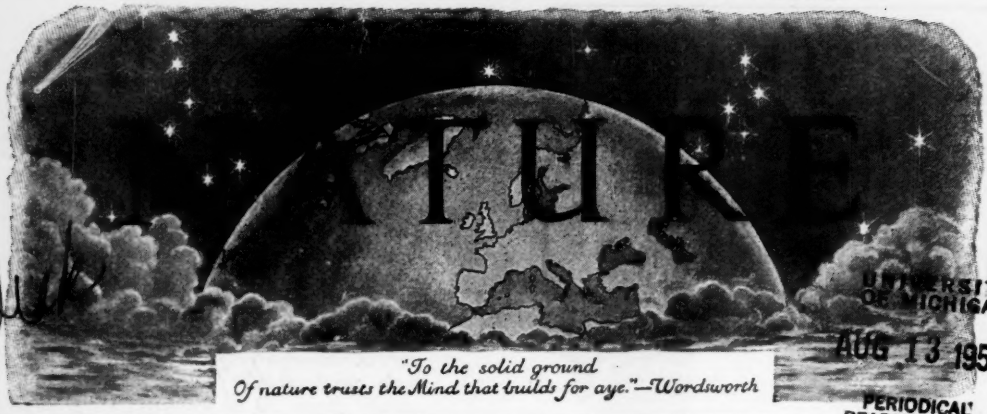

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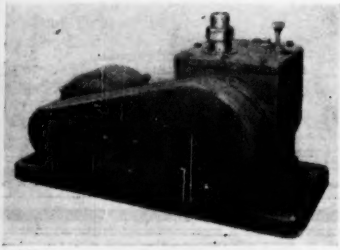

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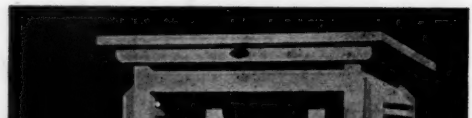

NATURE

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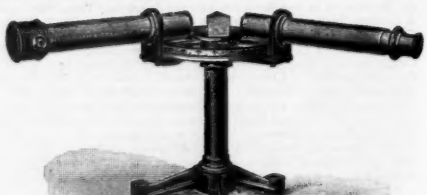

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A NEW OUTLOOK ON COAL

ON p. 171 of this issue is given a summary of the recent report issued by the Organization for European Economic Co-operation (O.E.E.C.) entitled "Europe's Growing Needs of Energy : How can they be Met ?" The report gives a detailed review of the energy supplies and requirements of the twelve European nations that support the Organization. It is the work of a Commission of Experts who have gone to great pains to consult the pertinent authorities that may be able to give a realistic view of the probable requirements of the future. The resultant estimates provide an attractive picture of the possible future growth in productivity and the standards of living in Western Europe as a whole, provided no abnormal events such as wars or economic upheavals intervene. At the same time, the Commission raises some useful warning signals as to the magnitude of the gap between the probable production of energy and the requirements associated with an expanding world economy. Many of these caveats apply particularly to the position of Great Britain, in regard to which the gaps between supply and consumption already bring a strain upon the national economy. Examination of the graphs provided in the report shows the prospect of more serious gaps between production and consumption developing at an increased rate between 1956 and 1975, which can only be met by imports of coal and oil.

The primary energy requirements of Western Europe by the target year of 1975 are likely to amount to 1,200 million equivalent tons of coal ; but the primary energy production, represented by coal, indigenous oil, natural gas and nuclear fuels is likely to amount to only 750 million tons. If this gap is to be bridged entirely by imports of coal and oil, their cost in 1975, based on present prices, would amount to some £1,800 million, to be paid for by equivalent exports of manufactured and other goods.

Looking particularly at the position of Great Britain, the energy consumption from various primary sources in 1954 was : solid mineral fuels, 80 per cent ; petroleum, 13 per cent ; hydro-power, 1 per cent.

Great Britain is the largest importer, the largest refiner and the largest consumer of petroleum products in Western Europe. Thanks to the abundance of coal resources and the high level of industrialization, the *per capita* consumption of energy in the United Kingdom is one of the highest in Europe. Nevertheless, the prospects that the gap between the production of indigenous fuels and the required consumption are to be met in the twenty years between 1956 and 1975 by any other means than imports of indigenous fuel are small. We have to face the situation that only one-fifth of the output of the coal industry in Britain in 1947 came from mines that had been sunk during the preceding thirty years. The gathering of the fruits of the more recent acceleration in investment must necessarily be delayed, because new mines and major constructions take many years to complete. British potential in hydro-electric development is small, and cannot be expected to cover more than 1 per cent of the present energy requirements. The recognition of this situation has been responsible for the special drive which has been made in the development of the industrial use of nuclear energy.

Such is the position : What are the warnings and the remedies ? The world's reserves of oil for the immediate future, and indeed in the period under review, are likely to be adequate to bridge the gaps envisaged. But what are the economic dangers ? The increase of consumption is based on the maintenance of the competitive position of the member countries in an expanding world economy, and from it stems the raising of their standard of living. The rapid increase in the dependence of Western Europe on imported energy brings in its train the inherent risks of availability of supply and certainty of rising prices for the imported fuels. A competitive position arises as to the demands of each of the member countries, and as to their economical production of raw or manufactured exports, whereby to pay for the imported fuel. The Commission emphasizes the warning and multiplies the exhortations as to the practicable means of limiting such requirements of imported fuels by developing further the indigenous production of all forms of imported energy. It is emphasized that coal will be the mainstay in Western Europe for many years. There has been a tendency to look upon coal as a back number. This situation is dangerous for the above reason. The view that nuclear energy is also 'round the corner' has also been overdone. The Commission is outspoken in its condemnation of a too optimistic attitude in this respect. False impressions as to the practicable contribution of nuclear energy to Western Europe's needs in the next twenty years have been created by the headline publicity given to developments of relatively small importance in this new field, and to the popular enthusiasm aroused by this new form of energy, a sentiment resembling the interest of a child in a new toy, and the inherent wonderment of man in the apparent magical.

Compared with some of the over-statements on fuel and energy policy that have appeared in many published utterances in recent years by would-be authorities, the conclusion of this report may be likened to a healthy fresh wind blowing through the narrow alleys of an overcrowded city on a hot day. Full note should be taken of the caveat that the public should be made to realize the need for a new outlook on coal. Coal is essentially a long-term industry lacking the flexibility of other industries. So far as Britain is concerned, the economic well-being of the country must still for many years depend upon coal. In effect, a shake-up of the public attitude towards research and development in the

use of coal is needed. Not only in these directions is an acceleration of interest and activity necessary, but also in the enhancement of the economic and competitive position of coal by improvements in distribution and marketing methods as well as in processing and coal-burning appliances. Finally, the general question of fuel efficiency, in regard to which the industrialist has possibly in recent years been over-exhorted to the point of passivity, is raised as a matter of great importance. Essentially the rate of progress in this field must depend primarily on the provision of the means of technological progress, the advancement of knowledge and of its means of application. The history of past performance in such fields in Britain has shown noteworthy advances. They can only be continued at an enhanced rate if the means in personnel, equipment and encouragement are provided.

PROPERTIES OF MATERIALS FOR ATOMIC ENERGY

Reactor Handbook

Materials—General Properties. Prepared by the United States Atomic Energy Commission. (Selected Reference Material on Atomic Energy.) Pp. xiii + 610. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 79*s*.

THIS handbook on materials is part of the general "Reactor Handbook" which has been issued in accordance with the overall programme for the organization and publication of information developed by the United States Atomic Energy Commission. Following the first chapter, in which the functions of reactor materials are described, the handbook attempts to put within one volume a summary of material selected as useful for metallurgists, ceramic technologists and other workers in the field of materials and related topics of reactor technology. No attempt is made to deal with other than solid materials which have been considered for use in reactors. The chapters, arranged alphabetically, deal with aluminium and its alloys, beryllia, beryllium and its alloys, beryllium carbide, bismuth, carbides, cements and concretes, graphite, hydrides, lithium and its alloys, magnesium and its alloys, molybdenum and its alloys, nickel and its alloys, plutonium and its alloys, rare earths, silicon carbide, stainless steel, thorium and its alloys, titanium and its alloys, tungsten, uranium and its alloys, vanadium and its alloys, and zirconium and its alloys. Materials of high cross-section and cobalt-base alloys are separately treated.

The method of presentation is similar throughout. After a general description of reactor application, availability and cost, extraction and purification are briefly dealt with, followed by sections on physical and chemical constants, mechanical properties, melting and casting, forming, fabrication, machining, joining and heat treatment. Corrosion behaviour and metallography are generally briefly treated.

The information presented refers to American practice, and if the handbook is judged from the British point of view omissions are apparent, as, for example, in the development of reactors cooled by carbon dioxide. In the United States this has received much less attention than in Britain, and thus the potentialities of magnesium as a reactor material have not been developed.

In general, for atomic energy applications, three main classes of material can be distinguished. First, suitable either as fuels or breeders, come uranium, thorium and plutonium. Secondly, the high- or low-absorption cross-section of materials like boron, cadmium, hafnium, beryllia, beryllium, bismuth, vanadium and zirconium make them suitable for specific atomic energy purposes. The third class contains the materials such as aluminium and stainless steel which have for years been in normal engineering use, and with which no effort on the part of the Atomic Energy Commission is required to determine relevant information. With this class there has been a greater dependence on existing publications—in particular, data sheets from manufacturers. It is difficult to select in a handbook just the right and appropriate amount of information from a large background of engineering literature. For that reason the chapters on such materials as steel and aluminium suffer so much by comparison with the chapters on materials specifically for atomic energy that the handbook would gain if they were omitted, except to point out, where appropriate, that certain features make them suitable for particular parts of power circuits.

With the first two classes, in which the material has been obtained from sources within the atomic energy project, the treatment and coverage are complete except where, as a result of security requirements, as with plutonium, the deletions have seriously affected the value of the information. With uranium the information given is restricted because of security requirements and also because the date of preparation is 1952. The all-important technique of canning is barely mentioned, even although uranium customarily requires protection for use in a reactor. A useful collection of equilibrium diagrams is reproduced. Much information about thorium is given, although the significance of the impact properties of the metal is not made clear.

Full information, given on beryllia, graphite, hydrides, cements and carbides and elements of high cross-section based on material developed from Atomic Energy Commission sources, is not readily available elsewhere. Although the effect of attack by liquid metals is not generally treated, its inclusion in the chapter on beryllium makes this more complete. The value of the chapter would have been greater if, instead of references, selected constitution diagrams had been given.

The chapter on bismuth is a useful reference which indicates its possibilities as a fuel-carrying vehicle and liquid-metal coolant.

As a reactor construction material, the potentialities of vanadium are noted, although the metal is sensitive to gaseous contamination and embrittlement.

For zirconium, the potentialities, once the metal is free from hafnium, are dealt with fully. Material containing as little as 50 p.p.m. of nitrogen is noticeably less resistant to corrosion in water than material containing 10 or 20 p.p.m. The resistance of zirconium sponge to water corrosion is decreased with increase of nitrogen content. A useful compilation of physical and mechanical properties and notes on the melting and casting, forming and fabrication, joining, machining and heat treatment enhances the value of the chapter.

The corrosion resistance of the metal is improved the purer the metal. A zirconium specimen may sometimes fail after a long time in water at 600° F. (316° C.), even though its composition cannot be differentiated from that of material which continues to have a low corrosion-rate for a much longer time. Impurities such as cobalt, molybdenum, tungsten, lead, zinc, thorium, vanadium, beryllium and oxygen appear to have little effect on the corrosion resistance, but tantalum and niobium and tin appear to have a beneficial effect. Notes are included on the corrosion of zirconium by solution and by gases such as air, hydrogen, oxygen and nitrogen and by liquid metals and fused salts. The chapter ends with notes on various zirconium systems, including zirconium, aluminium, carbon, chromium, iron, hydrogen, nickel, nitrogen, oxygen, thorium, tin, titanium and uranium, and is in general a useful contribution to the literature on reactor technology.

The chapter on graphite is informative but makes no mention of the behaviour of graphite in a neutron flux other than a passing reference to its susceptibility to irradiation damage at low temperatures. Useful comments are made on protective techniques for graphite.

The handbook was originally a classified volume for use in the Commission only, and the volume available to the general public suffers from limitations and reservations. In many instances a large number of the references quoted are classified. On the assumption that the list will eventually be declassified, it is wise to include such references; but this will not reduce the sense of frustration of a reader anxious to read further in the subject and denied access to the classified literature. As more information becomes declassified, this effect should be minimized.

There are a useful appendix of selected physical constants of the elements, and a table of thermal neutron absorption cross-section of the elements arranged in order of increasing magnitude. Tables of temperature conversions, engineering conversion factors, a metallurgist's periodic system, a glossary of metallurgical terms, a nomograph for interconversion of weight and atomic per cent, and a vapour pressure chart of metals are included.

Throughout the handbook a number of important observations occur representing the results of lengthy investigations. These will be recognized by the reader with personal experience of investigations in the field of atomic energy. A. B. McIntosh

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TIME AND LIFE

Evolution of the Vertebrates

A History of the Backboned Animals through Time. By Prof. Edwin H. Colbert. Pp. xiii+479. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 72*s.* net.

A Guide to Earth History

By Richard Carrington. Pp. xv+240+16 plates. (London: Chatto and Windus, Ltd., 1956.) 21*s.* net.

THERE are many reasons why vertebrate palæontology should be attractive, the principal being that the materials are macroscopic and the elucidation of them leads to the clarification of the sources and development of man himself. Furthermore, in Britain, France and the United States there is a long and interesting personal history attached to the growth of the subject. It may be significant that from these three countries there have recently come important contributions to the teaching literature on the vertebrate groups. These two books are of differing purpose, each of which reflects important aspects of approach.

Dr. E. H. Colbert's "Evolution of the Vertebrates" naturally takes precedence both in time and purpose, for the work is said to be designed for the general student and the lay reader, and the writing is certainly precise and lucid enough for both; but it will appeal most strongly to the advanced or graduate student who is already familiar with the zoological and physiological facts of vertebrate life.

Dr. Colbert sees the subject in the round, with all his experience as collector, museum conservator and university professor. He also knows the difficulty in deciphering much of the evidence and the ease with which the sensational rather than the conservative inference can be made. He therefore writes informatively but restrainedly.

The book covers the whole of the vertebrate field, individual groups being dealt with factually, but the overall, ecological, picture is not forgotten. It is made clear that the story of vertebrate evolution in time is not a series of changing geological scenes working up to a climax but rather a bubbling up of life that pervades the barriers of geological formations and overflows the boundaries of continents. Wisely, there are chapters on the relationships of faunas and tables of stratigraphical comparisons.

It is here that the European student will be more at a disadvantage than his American counterpart, for the richness of American discovery overshadows that of other countries and limits of space inevitably demand the omission of many interesting European forms. One feels that some of the references to European stratigraphical divisions are a little vague. Apart from this, there are very few lapses, though the student should observe that the word Oligocene does not mean "many recent" forms.

The production of the book and the illustrations by Mrs. Lois Darling are excellent. The latter are nearly all restorations, and some readers would have welcomed a few more factual or diagnostic illustrations of parts of animals. The phylogenetic diagrams are especially useful and attractive. The book as a whole will be a valuable addition to the class library and should be of great help to many British students as an additional source of information.

Mr. Richard Carrington's book, "A Guide to Earth History", covers an even wider field and is frankly addressed to the general reader rather than the student. Its author is a gifted writer and an amateur zoologist who has many qualifications for the task he essays, but he must depend on others for many of the facts in a book that covers the evolution of the Earth as well as that of the forms of animal and plant life that precede, and some of which lead to, the emergence of man. Sometimes this more vicariously acquired information betrays itself or dates itself as, for example, when the author writes that "fossils, for the last fifty or sixty years have been universally recognized for what they are". The repetition of the recapitulation theory is also probably an error of this kind.

But such things apart, the rest of the book makes a good introduction to the world of fossils and the evidence they provide of the history and progress of

life. The generally accepted facts are well, and sometimes finely, portrayed, and a large series of illustrations by Maurice Wilson help to round off the story. There is an especially good bibliography. Furthermore, the work is written from the European point of view. Many non-geologists will find this a highly satisfactory statement, and quite a number of geologists can use it as a stepping-stone to further, more academic, studies. W. E. Swinton

ASPECTS OF MARINE SCIENCE

Papers in Marine Biology and Oceanography

Dedicated to Henry B. Bigelow. By his former Students and Associates. (*Deep-Sea Research*, Supplement to Volume 3.) Pp. xx+498. (London and New York: Pergamon Press, Ltd., 1955.) 75*s*. net; 10.50 dollars.

In 1927 the United States National Academy of Sciences set up a committee, with Henry B. Bigelow as secretary, to report on the part which the United States should take in a world-wide programme of oceanographic research. One of the major results of the inquiry was the foundation of a new research institute at Woods Hole, Massachusetts, in 1930 with Bigelow as its first director, a post which he held for ten years, before asking to be relieved in order to devote more time to his own researches. To commemorate the twenty-fifth anniversary of the Woods Hole Oceanographic Institution, which now enjoys an outstanding reputation throughout the world, this volume has been prepared and dedicated to Dr. Bigelow by his former colleagues and students.

The forty-eight contributions to the volume comprise both original research papers and review articles. It would be impossible to review them individually or even refer to the names of all the authors or the titles of their papers. The impression which one gets from the volume as a whole is how well it bears out Bigelow's own view in 1931, expressed in his book, "Oceanography: its Scope, Problems and Economic Importance", of the essential unity of the science of the sea and the close interrelationships between all its aspects—biological, geological, chemical and physical. Many of the papers themselves deal with such relations, and others, while confining themselves to work in one field, can be seen, at the same time, to fall into a general pattern.

The zoological papers range from systematic studies, such as that by P. L. Kramp on medusæ, to those on the behaviour of animals in the sea. A review of the recent researches on hearing in fishes and cetaceans is given by D. R. Griffin. A. S. Romer, in "Fish Origins—Fresh or Salt Water?", examines the fossil evidence from European and American sources. Several papers are concerned with the relations between one kind of marine organism and another. C. E. Lucas's paper on external metabolites and E. Steemann Nielsen's on plankton algæ and bacteria are examples. Studies relating to the productivity of the sea and to problems of fisheries research are also represented.

A large group of papers is concerned with surveys of physical conditions, particularly water movements, and their relation to the circulation of nutrients and to the distribution of plant and animal life. Regional accounts are given of the Gulf of Venezuela by A. C. Redfield and of Long Island Sound by G. A. Riley. Discussing coastal currents and fisheries, C. O'D. Iselin refers to a new programme for the investigation of coastal currents which has been started at Woods Hole. G. Wüst contributes a study of current velocities in the deep and bottom waters of the Atlantic.

A number of papers deal with the geology of the ocean floor or the relation of sediments to the chemical or biological features of the water above them. A paper by the late H. C. Stetson discusses the differences between the Atlantic and Gulf terraces of the United States. An account of new instruments, by which they have taken water samples within 5–50 cm. of the bottom, is given by J. Bröuardel and L. Fage. There are papers by F. B. Phleger and by Frances L. Parker on foraminifera, and by H. Pettersson on manganese nodules and oceanic radium.

This volume gives a stimulating impression of the position of marine science to-day and of some of the lines along which one may expect future advances to be made. K. F. Bowden

EARLY SCIENCE IN MEXICO

Montaña y los Origenes del Movimiento Social y Cientifico de Mexico

Por Prof. José Joaquin Izquierdo. Pp. xvi+442. (Mexico, D.F.: Ediciones Ciencia, 1955.) n.p.

The colonization of the New World by Spain in the sixteenth century was carried out on an ambitious scale. In Mexico, then known as Nueva España, the Royal and Pontifical University was founded in 1553, and various types of medical institutions were also set up. At that time these establishments were as good as those of the Old World, but during the next two centuries, the many advances in science and medicine that were made in Europe did not reach or were not accepted in Mexico, and towards the end of the eighteenth century the courses in medicine taught in Mexico City had not changed in any way since they were instituted in the sixteenth century.

In this most interesting volume, Prof. J. J. Izquierdo has taken as his principal subject the life of the Mexican-born doctor, botanist and social reformer, Luis José Montaña (1755–1820); but interwoven with details of his life is a carefully documented account of the contemporary knowledge and teaching of science and medicine in Mexico, so that it is in effect a study in the history of science rather than a biography.

Montaña was a child of unknown parentage, reared in an orphanage, whose intelligence and aptitude for study took him to the University of Mexico, where he first graduated B.A. in 1771 and then took up the study of medicine. At that time the five chairs in medicine at the University included one in astrology, and Hippocrates and Galen were still the revered masters. There was no connexion with the hospitals and no clinical teaching. It was not until at the end of the eighteenth century that the advances made in Europe began to be recognized and accepted in Mexico; and in their gradual introduction Montaña played an important part.

Montaña was interested in botany and the pharmacological uses of the native plants. The dispatch in 1787 of a scientific expedition from Spain

to collect and study Mexican plants, and the opening in 1789 of a Royal Botanic Garden in Mexico City itself, furnished Prof. Izquierdo with material for a particularly interesting botanical chapter, which includes some account of the herbal knowledge of the Aztecs.

Montaña's belief that medicine should be scientific, and studied in conjunction with the natural sciences, brought him into association with the progressive party. The story is an involved one, linked with a particularly stormy period in Mexican politics, and the reforms he sought to establish were not achieved until some thirteen years after his death.

This well-printed book, illustrated with many reproductions from contemporary literature, has an appreciative preface by Prof. H. E. Sigerist. It is a welcome addition to accounts of scientific progress in the Americas. An English translation would be valuable and enable it to reach a larger circle of readers.

J. M. EYLES

MAGNETIC AMPLIFIERS

Magnetic Amplifiers

By H. F. Storm. (Contributors: E. F. W. Alexanderson, H. H. Britten, W. D. Cockrell, F. J. Ellert, E. A. Harty, H. W. Lord, W. Morrill, H. M. Ogle and P. A. Vance.) (General Electric Series.) Pp. xix+545. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 108*s*. net.

THE early development of the magnetic amplifier was slow, probably because of the competitive influence of the electronic valve. During recent years this early neglect has been remedied, and there is now a great mass of technical articles describing developments of this robust and useful piece of apparatus. There have, however, been very few books published on this subject, and most of them have not been major works.

The issue of a 550-page book by Dr. H. F. Storm and his colleagues of the General Electric Co., Ltd., is both welcome and opportune. The advantages of having parts of a subject covered by different specialists in one book is normally obtained at the expense of some lack of continuity in the treatment, and this book is no exception; but Dr. Storm has written Chapters 4–20, covering the whole theory of the amplifiers, so that a large part of the book forms a satisfactory unit.

The first three chapters include the theory of magnetism, a description of magnetic materials and methods of testing them. Then follow Dr. Storm's chapters, and finally there are chapters on core and coil assemblies, metallic rectifiers and various applications of amplifiers.

Dr. Storm's treatment of the magnetic amplifier emphasizes the difference between operation with free even harmonics and suppressed even harmonic currents. Not all readers will agree that this is the best approach to the subject; but his treatment is clear and thorough, and he deals with both the steady-state operation and transient operation with resistive and inductive loads in considerable detail. He then covers the operation of feedback, including the amplistat and the bridge amplistat. Some aspects of the subject are not adequately covered, as, for example, the use of push–pull amplifiers and high-speed amplifiers, but this is a minor blemish in an otherwise excellent work.

Dr. Storm's mathematical arguments are often made needlessly difficult to follow by references to earlier equations which are spread over several chapters. A little judicious repetition of these equations would simplify the reader's task without adding unduly to the volume of the book. The figures are clear and well chosen, and there is a remarkable freedom from misprints in both text and figures in the chapters written by Dr. Storm; but the standard is rather less high in the other chapters.

This is a book which all serious students of the magnetic amplifier will need to have, but it is of postgraduate standard and is not easy reading. The highly glossed paper on which the text is printed is tiring to the eyes.

TEXT-BOOK ON HEAT ENGINES

Technology of Heat

By Prof. H. Wright Baker. Pp. xiii+427. (London and New York: Longmans, Green and Co., Ltd., 1956.) 36*s*. net.

WITH few exceptions, the contents of this book fall within the compass of what has until recently been called heat engines. There are various approaches to the theory of heat engines, and the author, Prof. H. Wright Baker, is to be congratulated on the line which he has followed in this work.

Although much is already familiar from Prof. Baker's edition of "William Inchley's Theory of Heat Engines", a broader background is given to the material. This has been arranged to introduce the diagrammatic representation of states, processes and working cycles at the earliest possible opportunity. Armed with this knowledge, the student (used in the generally accepted sense) is in a position to tackle the succeeding chapters on air compressors, steam engines and turbines, internal combustion engines, the gas turbine, and refrigerators and heat pumps, because all these chapters include a copious supply of cycle diagrams. As a direct consequence of the diagrammatic approach, steam and gas turbines appear as separated items.

Fuels and combustion are not confined to the chapter with that heading, additional information being given throughout the book. Both the title "Technology of Heat" and the preface heading "An Introduction to the Industrial Uses of Heat" give the impression that these aspects receive more detailed attention than they in fact do. For example, little is said of liquid fuels, and notable omissions are mentions of heat of formation, liquid fuel burners, and kinetics of combustion. Perhaps a little space could be found for mention of these at the expense of some of the matter referring to the reciprocating steam engine.

The chapter on heat transfer is welcome for the amount of information it contains on the radiation, conduction and convection processes. The final chapters deal with more practical aspects, namely, waste heat recovery and heat balances, and notes on testing. Example questions are appended to most chapters.

Although not including any innovations, this book is to be recommended to students working for degrees, Higher National Certificates, etc. As a general introduction to a very broad field of study, it requires additional references to more specialized books and articles.

T. D. PATTEN

Rectangular-Polar Conversion Tables

Designed and compiled by E. H. Neville. (Royal Society Mathematical Tables, Vol. 2.) Pp. xxxii+109. (Cambridge: At the University Press, 1956. Published for the Royal Society.) 30*s*. net.

THE problem of determining the polar co-ordinates (r,θ) of a point with Cartesian co-ordinates (x,y), according to the equations $x = r\cos\theta$, $y = r\sin\theta$, is a common one presenting no theoretical difficulty. In particular, the solution of algebraic equations by root-squaring necessitates the conversion in complex form (that is, $z = x + iy = re^{i\theta}$), and (to quote the author's words) without a quick passage between corresponding pairs of values, the process is a flight of fancy rather than a technical revolution.

Almost all the tables hitherto available for the above conversion have been single-entry in character, employing the argument $t = y/x$ and then working in terms of arc tan t and $\sqrt{(1 + t^2)}$. The use of two independent variables, for which purpose this volume is primarily designed, clearly facilitates the calculations and obviates the danger of serious numerical errors.

The table covers the triangular range $1 \leqslant y \leqslant x \leqslant 105$, the upper limit 105 being chosen as convenient for typographical purposes. The arrangement of the entries is extremely ingenious, each page containing exactly 106 pairs of entries to 15 decimal places. To explain the detail of the arrangement, it is sufficient to take a page at random, say p. 35, and to describe its contents. These are $x = 35$, $y = 1(1)35$, with values of r and θ in degrees, followed by $y = 35$, $x = 35(1)105$, with values of $\log_e r$ and θ in radians. As will thus be seen, the logarithm table not only provides symmetry but also avoids repetition.

A substantial introduction precedes the main table just described and is mainly concerned with methods of interpolation required in using the table. Many illustrative examples are provided, and no effort has been spared to clarify the details of the numerical computation involved.

A bibliography of relevant and collateral tables is also provided, and the volume concludes with six supplementary tables, which include page-indexes for r and $\log_e r$ and the first 1,688 integer-denominators of the Farey series of order 105, the use of which is required in the interpolation methods.

J. H. Pearce

Second Thoughts on Radio Theory

By "Cathode Ray" of *Wireless World*. Pp. 409. (London: Iliffe and Sons, Ltd., 1955. Published for *Wireless World*.) 25*s*. net.

THIS collation of articles contributed by "Cathode Ray" to the *Wireless World* during the past twenty-five years forms a kind of running commentary on the development of radio theory during the period. The impenetrable pseudonym might stand for a synthetic figure, made up of experts of the panel; but the characteristic manner of writing suggests that one person, and a very forceful person, too, is the author of them all. In any event, one feels that during this period few individuals can have done more to encourage and browbeat radio engineers to face fundamental difficulties and think out the solutions for themselves.

The book contains some forty articles on basic ideas, circuit elements and techniques, and calculations. Each article starts in a simple fashion; but the topic is dissected and discussed so thoroughly in detail that towards the end the reader is being piloted skilfully through the deeps. The light conversational style which is "Cathode Ray's" own way of driving his points home may not appeal to everybody; but there is wisdom and sound judgment behind it. Intolerance of jargon and slipshod thinking, and an irreverence towards the pundits who frame definitions in a spirit of confusion, flash out fiercely from time to time. It is good to see so many of these articles together in permanent form, and the publishers are to be congratulated on an excellent volume.

G. R. Noakes

The Biology of a Marine Copepod

Calanus finmarchicus (Gunnerus). By Dr. S. M. Marshall and Dr. A. P. Orr. Pp. vii+188+18 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1955.) 21*s*. net.

NEARLY two hundred years ago *Calanus* was discovered in northern Norwegian waters and classified by its discoverer, Bishop Gunnerus of Trondheim, as *Monoculus finmarchicus* among the "Insecta Aptera". As an important link in the marine food chain, especially as a staple food of the herring, this copepod has become the object of study of workers in a great variety of branches of biology.

The authors, having themselves worked on *Calanus* for many years, have written a well-produced and eminently readable survey of knowledge concerning the systematics and distribution, the anatomy, reproduction, development and life-cycle of the animal. Chapters dealing with biometrical data, the animal's chemical composition, its food and feeding mechanism, lead to a summary of work on its respiration, vertical migration, and its relation to inorganic and organic environment.

An extensive list of references and a most carefully prepared index add to the value of a book which should prove to be an asset to zoologists, marine biologists and naturalists alike.

Clays and Clay Minerals

Proceedings of the Second National Conference on Clays and Clay Minerals, University of Missouri, October 15–17, 1953. Edited by Ada Swineford and Norman Plummer. (Sponsored by the Committee on Clay Minerals of the National Academy of Sciences—National Research Council; University of Missouri; State Geological Survey of Kansas.) Pp. viii+504. (Washington, D.C.: Publication 327, National Academy of Sciences—National Research Council, 1954.) 4 dollars.

DURING recent years the study of clays and clay minerals has received much attention, and the widespread interest in the subject has been fostered by the establishment of national and international groups and committees. In the United States, a National Conference on Clays and Clay Minerals, the second of its kind, was held at the University of Missouri in the autumn of 1953, and this volume is a record of the proceedings. It contains thirty-seven separate contributions from authors with a wide variety of experience, dealing with the geology, genesis, chemistry, mineralogy, crystal structure and physical and mechanical properties of clay deposits and clay minerals, and includes a number of X-ray studies. The volume is well printed and illustrated, and adequately indexed, and forms a valuable contribution to the literature of clays.

ENERGY REQUIREMENTS OF EUROPE

THE report on Europe's future needs of energy recently issued* by the Organization for European Economic Co-operation contains a most interesting examination of the position and includes a number of important recommendations which have been derived from a detailed study by a group of experts. This study has comprised the collection and examination of data and opinions emerging from international organizations and professional circles able to provide the pertinent information.

The report reveals that the consumption of all forms of energy in Europe, which in 1955 was equivalent to 730 million tons of coal, is rising so rapidly that in 1975 it is likely to reach a figure equivalent to 1,200 million tons of coal. This forecast is based on a maintenance of the competitive position of the member countries of the Organization for European Economic Co-operation in an expanding world economy, and the consequent raising of their standards of living.

According to the report, the share of the total requirements expected to be covered in 1975 by the production of primary energy in Western Europe will amount to an equivalent of 750 million tons of coal, as against 580 million tons in 1955. It emphasizes that it would be erroneous to believe that nuclear energy will make large contributions to the supply of energy available in Western Europe in the next twenty years. Rather is the limit of this contribution put at 80 million equivalent tons by 1975, or only 8 per cent of the total requirements. Unless a special effort is made to promote the indigenous production of primary energy, the remaining gap between energy requirements and indigenous supplies would have to be bridged by imports of coal and oil, the cost of which would amount in the target year 1975 to about £1,800 million at present prices. This may well present a formidable problem for some member countries in its effect on the balance of payments. The dependence of Western Europe on imported energy, with its inherent risks as regards matters of both economics and security, and the certainty of rising prices, must imply the serious need for a determined effort on the part of all member countries to develop further their indigenous production of all forms of energy. All reserves of energy will be needed in the future, and it is important to note that coal will be the mainstay of the energy economy in Europe for many years to come. Further, an increased output of coal must depend on long-term investment, on the development of improved mining methods, and on adequate terms of miners' pay and employment. In effect, coal must be given the outlook of a modernized and stable industry, which will attract able young men to join it. No doubt in time the competitive position of the coal industry may be affected, for after 1975 nuclear energy is expected to free the coal burnt in thermal power stations to an increasing extent. Nevertheless, this coal will be needed for other purposes for which nuclear energy cannot replace it. Meanwhile, the ultimate importance of nuclear energy and the difficult and novel problems involved in its development should induce member countries, both jointly and individually, to make a large and technological effort in the nuclear field. Additional effort will be necessary in the harnessing of undeveloped sources of hydro-power and for new sources of oil and natural gas.

The share of oil in supplying the energy needs of Western Europe must also rise rapidly. The concomitant factors governing this rise are the increasing consumption of oil for transport of all kinds, the advantages of oil for certain purposes and its increasing use as a substitute for coal owing both to its lower cost and to the shortage of coal. The world's reserves of oil will be adequate for this requirement, but large investments must be made by the oil companies in Western Europe as well as abroad.

Special importance is attached to the up-grading of primary into secondary forms of energy, such as gas and electricity. These latter are essential to a rise in productivity of many industries and are associated with improvements in the standards of living. These secondary forms of energy are the means of utilizing with the greatest efficiency the limited supplies of primary energy, and contribute to their greater adaptability. The fact that they can be produced with the aid of different forms of primary energy introduces an element of flexibility into the energy economy, which serves to lessen the rigidity inherent in the coal industry.

A potent factor in reducing the menacing gap between indigenous production and the overall requirements of energy resides in the still existing possibilities of saving energy by economies at every stage, from its winning and conversion in the energy industries to its final utilization in industry and in the home. The European Productivity Agency of the Organization for European Economic Co-operation is called upon to render assistance in this field, and member countries are urged to institute organized efforts for the purpose of energy saving.

The report urges Governments to give competition full play, in order that the consumer may be able to have maximum choice between the different forms of energy. This requires Governments to establish energy policies suited to their own circumstances, needs and resources in order to deal effectively with the urgent problems in the demand for and the supply of energy. The establishment of such policies should include some co-ordination between the different forms of energy, and be followed by the recommended co-ordination of the separate Governments' energy policies. This would result in increased co-operation at international level. At the same time, it is recommended that Governments should endeavour to avoid legislative or administrative restrictions likely to retard the development of sources of energy, or to jeopardize their efficient utilization. Further, in the framing of overall social, economic and financial policies, due consideration should be given to the effects of taxation, price maxima and wages structures on the efficient production and use of energy.

Other means of co-operation are recommended in this report. There are important chapters on the

* Europe's Growing Needs of Energy: How can they be Met? A Report prepared by a Group of Experts. Pp. 120. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1956.) 400 francs; 8s.; 1.25 dollars.

financial aspects of the energy problem; thus in energy prices, the impact of such prices on the balance of payments, and the investment needs of the energy industries in the period under review, are considered. In this context, there is recommended the mutual supply of capital needed for the production of energy as well as the pooling of research and development programmes. Again, it is considered to be of mutual benefit for member countries to increase their co-operation in the fields of exchange of energy, of man-power for the production of energy and of information and experience.

In the final chapter of the main report, it is pointed out that only a cursory examination of the many important general problems envisaged was practicable. More detailed examination was therefore necessary, and it proposes the setting up of a new committee of individuals selected for their experience in this field, to act as advisers to the Organization. Not only should this new committee examine the conclusions of the present report and follow their implementation, but also it should review periodically both energy statistics covering the pertinent factors, and, with the help of the economic and other technical committees, the forecasts of energy requirements and supplies. The terms of reference should also include the search for problems which need further investigation.

Extensive appendixes are attached to the report. They indicate the sources of the information obtained, which covered an authoritative field concerned with trade union and managerial responsibility. The forecasts on which the main conclusions have been based were derived by four independent methods. Assumptions were made as to the anticipated level of employment, the standard of productivity, the level of working hours and, most important of all, that no abnormal events would intervene, such as a war.

Most valuable to the general interested reader are the reviews of the energy situations in the individual countries concerned, some twelve in number. They give the individual statistics for the various sources of energy as to production, the reserves and future prospects, the most important of the pertinent factors as to imports and exports of energy, and the developments in the nuclear field.

Of the primary sources of energy in the period 1956–75 in Western Europe, the annual production of coal may increase, according to present plans, from 480 million tons, as at 1955, to 520 million tons; but some further capacity must be provided to replace exhausted pits, to the extent of 190 million tons per annum. These additions will call for investments in the neighbourhood of £3,000 million, exclusive of coke ovens, pithead power stations and briquetting plant. Lignite, mostly in Germany, will require £570 million. Water developments to result in an increase of about 150 per cent capacity in 1975, as compared with 1955, may cost some £7,600 million. Indigenous sources of oil and natural gas are less tangible factors to assess, but are expected to require a sum equivalent to that of coal, namely, £3,000 million.

For the provision of secondary energy, coke and coal gas will require a sum slightly in advance of this last figure, and for thermal electricity the overall investments may amount to the considerable figure of £17,700 million. This is exclusive of the provision for transmission and distribution of electrical energy. The total investment to cover all requirements in the period 1955–75 could reach the astronomical figure of £50,000 million, or an annual average of £2,500 million. The investment provided in 1955 was £1,580 million. Thus an increase by some 60 per cent of outlay is included in the present plans for development.

The report is illustrated by a number of graphs, relating to the position and the prospects in the United Kingdom, France, Switzerland and Sweden, which emphasize clearly the importance of coal to Great Britain.

R. J. Sarjant

THE MEASUREMENT OF BODY RADIOACTIVITY

CONFERENCE AT LEEDS

THE problem of measuring the radioactivity of the human body is exciting interest in many countries. A conference, the first of its kind devoted to this problem, was held during April 16 and 17, in the Department of Medical Physics of the University of Leeds. Delegates attended from Denmark, Sweden, Germany, the United States, Canada, Australia and Great Britain, and they included representatives from almost all the groups known to be engaged in this field.

In a short introduction, Prof. F. W. Spiers outlined the aims of the conference. Of first importance was the bringing together of as many as possible of those actively working on the problem of body radioactivity and others interested directly in it. It was intended to consider particularly the external methods of measuring body γ-ray emission and their possible limits of sensitivity. High-pressure ion-chamber techniques are already adequate, he said, to measure amounts of γ-emitters in the body of the order of 2 ng. radium equivalent (1 ng. = 10^{-9} gm.,) that is, well below the recommended maximum permissible levels[1]. An improvement in γ-sensitivity of ten times appears to be feasible with scintillation techniques, but perhaps the special importance of the latter is in their possible application to measuring very low levels of β-emitters in the body. The conference would also include consideration of techniques other than external detection giving data on body radioactivity.

Papers were read by representatives of each of the three groups who have used high-pressure ion-chamber methods. Dr. B. Hultqvist (Institute of Radiophysics, Stockholm) discussed results obtained at Stockholm using two arrays each of twelve high-pressure chambers in a laboratory which, being at 55 metres depth below solid rock, is well shielded from cosmic rays. To exclude local radiation, walls, floor and ceiling are lined with tanks containing Thames water (since this has a considerably lower

radioactivity than Stockholm water) and the radon content of the air is reduced by forced ventilation. With these precautions to reduce the background, the maximum uncertainty of a single measurement on a human being, taking 3–4 hr., is ± 1 ng. radium equivalent. Published results[2] include investigations of 306 normal individuals divided into three age groups, and it appears that differences are due to potassium content rather than radium, and that for uncontaminated persons the radium content is well below 1 ng. Differences in the radium content of drinking water supplies are insufficient to account for all the differences in radium content. Dr. Hultqvist also described a survey of the radon and thoron content of air in Swedish homes of various building materials[3], and showed that the accumulated radioactivity is greater in the lungs than in any other part of the body, a factor to be borne in mind in whole-body measurements.

Mr. J. Rundo (Atomic Energy Research Establishment, Harwell, formerly at the Finsen Laboratory, Copenhagen) next described the apparatus at Copenhagen[4] which was designed at Harwell following the pattern of that at Leeds. It uses four measuring cylinders together with four 'backing-off' chambers and a vibrating-reed electrometer feeding into an automatic recorder with an averaging device. Its chief application has been in the study of thorium burdens, a complex problem involving such unknown quantities as the fraction of each daughter product that might be present and, in many cases, the duration of the burden. By calibrating the apparatus with bottled samples of thorium dioxide at different known fractions of radioactive equilibrium and also by means of a model in which the thorium is realistically distributed, it is possible to make reasonable interpretations of the body measurements. Some use of the apparatus has also been made in bremsstrahlung measurements on phosphorus-32 administered to patients.

Experience with the Leeds apparatus was described by Dr. P. R. J. Burch (Department of Medical Physics, University of Leeds). Dr. Burch spoke of the basic considerations concerning the sensitivity and calibration of a body γ-ray monitor. In the case of high-pressure integrating ion-chambers, the cosmic-ray component of the background contributes most of the statistical error. A chamber design was described which should enable errors to be reduced by a factor of from two to three by ensuring that most penetrating cosmic-ray particles would produce roughly equal amounts of ionization both in the register and the backing-off chambers. The principle is being incorporated in an apparatus for recording the γ-ray intensities from the atmosphere and ground, together with the cosmic-ray intensity. Application of the idea to a body γ-ray monitor should enable the normal body γ-ray emission to be measured with a probable error of ± 5–10 per cent in an observation period of 2 hr. By using different wall materials, different gases and different gas pressures in chambers above and below the body, a considerable measure of discrimination of radiation quality would be possible. However, for clinical studies an apparatus is needed capable of giving a standard error of about 2 per cent in a short (¼-hr.) measurement, and the apparatus under construction designed to achieve this was described. Five tank units containing a liquid scintillator and each viewed by two photomultipliers will be mounted around a chair on which the patient reclines. The components of this apparatus, the steel-shielded room in which it is to be used and also the original high-pressure ion-chamber apparatus[5] were available for inspection.

In the discussion following the three papers on high-pressure chamber techniques, mention was made of the importance of avoiding errors due to contamination from clothing and from radon or thoron in patients' breath, and even due to the potassium-40 content of reading material used by the patient during measurement.

The first afternoon session (with Dr. K. Z. Morgan, of the Oak Ridge National Laboratory, United States, in the chair) was devoted to scintillation techniques. Dr. E. C. Anderson (University of California, Los Alamos Scientific Laboratory) described work with the Los Alamos scintillator[6]. He pointed out that the principal advantage of the large liquid scintillator lies in its high sensitivity, permitting the use of short observation times. This greatly increases the scope and capacity of the apparatus. Moreover, with liquid scintillators, almost the entire solid angle around the patient may be filled, as compared with the 10^{-2} or 10^{-3} convenient with sodium iodide crystals. Since sensitivity is dependent on the ratio (sample)^2/background, the advantage of high counting-rates is obvious. The present Los Alamos apparatus has a cylindrical space 18 in. in diameter in which the patient lies. The surrounding 500 litres of liquid scintillator is viewed by an array of 108 photomultiplier tubes, each 2 in. in diameter. The whole is screened by 5 in. of lead, with 2 in. of lead at the patient's head. An exposure of 2 min. is adequate to estimate the normal potassium content of the body with a standard error of ± 10–20 per cent. Statistical stability of the background is better than 1 per cent, which corresponds to 5 per cent in the normal body measurements. Measurements of body activity against age and sex give essential agreement with those described earlier by Dr. Hultqvist. An improved correlation has been found if the potassium-40 activity of each patient is plotted not against gross, but against lean, body-weight. The latter is found by a tritium determination of body-water, which is assumed to be 70 per cent of lean body-weight.

It was a disappointment that Mr. Marinelli's group (Argonne National Laboratory), which has made such notable contributions to the subject, could not be represented. Dr. Anderson was able to include in his paper a description of the work being carried out at Argonne with a single large sodium iodide crystal in conjunction with a room lined with 8-in. steel. The extreme sensitivity of the apparatus was indicated by its detection of what may be traces of cæsium-137 from radioactive fallout, the emission of 0·66 MeV. radiation from tested humans corresponding to a level of 0·005 μc. of cæsium-137 if this interpretation is confirmed.

A joint paper on scintillation techniques by Dr. Denis Taylor and Mr. R. B. Owen (Atomic Energy Research Establishment, Harwell) was read by Mr. Owen after a brief reference by Dr. Taylor to preliminary scintillation work done in connexion with the Copenhagen project. It described an apparatus utilizing four sodium iodide crystals (1¾ in. in diameter, 2 in. thick) giving a standard error for normal body radioactivity of 10 per cent for a 10-min. observation. In its application to phosphorus-32, the standard deviation was equivalent to 30×10^{-9} c. of the isotope. It is proposed to use larger crystals (4½ in. in diameter × 2 in.) with a reduced potassium

impurity, when the standard deviation on a 10-min. exposure should be only 3 per cent. A further reduction may be possible if still purer crystals combined with top-channel analysis are employed. Mr. Owen considered the sensitivity to be expected with the proposed apparatus in the detection of americium-241 and plutonium-239 in the body. He believes that it may be possible to measure 6×10^{-9} c. of americium-241 from the 59-kV. emission and amounts of the order of the maximum permissible level of plutonium-239, utilizing its 17-keV. X-rays.

In the discussion which followed, it was suggested that the location of plutonium in bone may reduce Mr. Owen's estimate, while Dr. Roesch (G.E.C., Richland, Washington) quoted measurements of transmission of plutonium-239 radiation through patients which suggested a factor of 30–40 for absorption from centre to surface of the chest. Although on present evidence it seems that the measurement of a fixed skeletal burden of plutonium would be difficult, the detection of a recently inhaled burden while still in the lungs appears feasible. In closing the scientific session of the first day, Dr. Morgan stressed the need for applying, if possible, the methods of measuring body radioactivity to the determination of the distribution fractions and effective rates of elimination for various organs for cases of single ingestion as well as for continuous exposure.

The second day's scientific programme was devoted to indirect methods of measurement of body burdens. The morning session, under the chairmanship of Dr. Katharine Williams (Atomic Energy Research Establishment, Harwell), was opened by Dr. Wright H. Langham (University of California, Los Alamos Scientific Laboratory) with an account of the application of urine excretion studies to the determination of plutonium in the body. The urinary excretion curve for plutonium is best fitted with a power function ; fæcal excretion is similar but with different parameters. Measurements of urine samples taken on different occasions may be matched to the theoretical power-law curve and the effective limits of exposure deduced. Where the ratio of fæcal to urinary excretion is very high, it is suggested that unabsorbed particles from the lung have found their way up the trachea and have thence been swallowed. Dr. Langham suggested a division of hazard according to the solubility of the plutonium particle and proposed a model of lung mechanism on the basis of which, in the case of insoluble particles, the lung burden is ten times the systemic burden, agreeing fairly well with calculations based on the fæcal/urinary ratio. However, the difficulties inherent in excretion analysis emphasized the desirability of whole-body measurement for plutonium if feasible.

In answer to a question, Dr. Langham said that there is remarkable uniformity in the excretion patterns of different individuals, possibly a consequence of plutonium being chemically unlike any element naturally found in the body.

Dr. J. B. Hursh (University of Rochester) then spoke of the radium content of cremation ashes, natural waters and some common foods. His results[7] for whole-body cremation ashes based on radon assay are about 1/100 of Krebs's earlier value[8] of 10^{-8} gm. average radium content, and Dr. Hursh reviewed other American work giving results in agreement with the lower value. He next described measurements on the radium content of natural and filtered waters in various parts of the United States and showed that they do not bear out the theory that drinking water is the main source of radium burden. The radium content of several common foods has been analysed and suggests that they are a possible source of at least a part of the normal burden.

It was apposite that the next paper was read by Dr. H. Muth (Max-Planck Institute for Biophysics, Frankfurt-am-Main) on measurements of normal radium burdens, for he and his colleagues have likewise measured the activity of cremation ashes of German subjects, and their results are in agreement with those of Hursh and Gates[7]. They measured the radon content by a dual ion-chamber system and also by α-pulse counting. In addition, measurements were made of the activity of various tissue samples, which were consistent with the total-body results. Dr. Muth described determinations of radioactivity of drinking water supplies, wells and thermal springs, and also gave preliminary figures for the radium content of some foodstuffs. The general agreement with Dr. Hursh's results was very satisfactory.

In the discussion, Dr. K. Z. Morgan stressed the importance of a knowledge of the radium content in the gonads, Dr. Muth having included some relevant data in his paper.

The final afternoon session, under the chairmanship of Dr. M. Faber (Finsen Laboratory, Copenhagen), was opened by Mrs. M. M. Hindmarsh (Nuffield Institute for Medical Research, Oxford) presenting studies by herself and Dr. Janet Vaughan on α-track measurements of radium in bone. She described photomicrographic and autoradiographic studies of sections of bone from a man, much of whose working life had been concerned with the handling of radium. In general, radium in the shafts was associated mainly with the Haversian systems, whereas in the ends it was concentrated in regions of high calcification. The calculation of body burden from α-track counting was described[9]. Emphasis was laid on the non-uniformity of distribution and it was pointed out that the dose in a small cavity (5μ) might be twenty times the average assessed on the basis of uniform distribution.

Prof. F. W. Spiers described a joint investigation with Dr. Burch in which γ-ray measurements on the same case were compared with α-track results reported in the previous paper. It had been possible to measure the γ-ray emission from the cadaver eight hours after death and afterwards to measure a number of representative bones in sealed containers after radioactive equilibrium between radon and radium had been attained. The total radium burden (0·48 μgm.) estimated from the bone measurements indicated that at the time of death the radon excretion in breath was 65 per cent. A body radium burden of 0·39 μgm. deduced from the α-track studies is in reasonable agreement with the γ-ray assay in view of the limited number of sections counted. It has been shown that the total life-dose to osteocytes in a 5-μ canal is of the order of 1,200 rad and not very dependent on the assumptions on period of intake. An estimate was also given of the distribution of dose to the bone marrow.

In a paper on the importance of radon and its decay products for the normal radiation dose in humans, Dr. A. Schraub (Max-Planck Institute for Biophysics, Frankfurt-am-Main) considered the influence of geological and meteorological factors on the distribution of radon and its products in the soil, the atmosphere and water supplies. Figures were

given for air concentrations in various sites and conditions, and the dose to the lungs of city dwellers estimated on the basis of measurements of air content of closed rooms.

The final paper, by Dr. W. P. Grove (Radiochemical Centre, Amersham), described experience with the measurement of radon in breath, a method which is specific to radium. The procedure for obtaining a representative sample of breath was described and details given of a technique for collecting the charged active deposit electrically on a metal foil coated with a phosphor for scintillation counting. Several cases had been sent to Leeds for total γ-measurement, and comparison with the exhaled radon suggested an excretion of about 60 per cent.

Reviewing the whole meeting with special reference to external methods of measuring body radioactivity, it could be concluded generally that scintillation techniques have reduced the limits of detection of 'hard' γ-emitters from figures of the order of 2×10^{-9} c. in a 2-hr. observation with ion chambers to about 10^{-10} c. obtainable in 15 min.; and that β-emitters such as phosphorus-32 can be detected at levels of the order of 3×10^{-8} c. Detection of levels of this latter order appears to be possible for a weak γ-emitter such as americium-241.

It was generally agreed that the success of the conference was in large measure due to its informality and to the many opportunities for discussion it afforded. Delegates were entertained by the Board of Governors of the United Leeds Hospital during the scientific sessions held in the Leeds General Infirmary, and also by the University of Leeds at a dinner at which the vice-chancellor, Sir Charles Morris, presided.

It is hoped in due course to publish in full the proceedings of the conference in a single volume.

G. W. REED

[1] Recommendations of the International Commission on Radiological Protection, *Brit. J. Radiol., Supp.*, 6 (1955).
[2] Sievert, R. M., *Strahlentherapie*, **99**, 185 (1956).
[3] Hultqvist, B., *Kungl. Svenska Vetenskapsakademiens Handlingar*, **6**, No. 3 (1956).
[4] Rundo, J., *J. Sci. Instr.*, **32**, 379 (1955).
[5] Burch, P. R. J., and Spiers, F. W., *Nature*, **172**, 519 (1953).
[6] Anderson, E. C., *et al.*, *Nucleonics*, **14**, 26 (1956).
[7] Hursh, J. B., and Gates, A. A., *Nucleonics*, **7**, 46 (1950).
[8] Krebs, A. T., *Strahlentherapie*, **72**, 164 (1942).
[9] Spiers, F. W., *Brit. J. Radiol.*, **26**, 296 (1953).

ECOLOGY AND NATURE CONSERVATION

A MOST successful meeting was held in Edinburgh during June 20–28 by the International Union for the Conservation of Nature and Natural Resources, hitherto known by the misleadingly restricted title of International Union for the Protection of Nature. There was an excellent attendance both of animal and plant ecologists, and of administrators, engineers, town-and-country planners, foresters and other interested professions. More than thirty countries were represented. Among the visiting scientists were: Prof. Roger Heim (president of the Union), director of the Paris National Museum of Natural History, and Profs. J. G. Baer (Neuchatel), E. Beltran (Mexico), H. Gams (Innsbruck), T. Monod (Dakar), and Dr. Ira Gabrielson (United States) (all members of the executive board), and also Profs. J. Berlioz and F. Bourlière (Paris), Prof. G. P. Dementiev and Dr. L. K. Shaposhnikov (U.S.S.R. Academy of Sciences), Dr. W. Engelhardt (Munich), Dr. E. H. Graham (United States Soil Conservation Service), Dr. A. Marcello (Italy), Prof. G. J. Van Oordt, Mr. M. F. Morzer-Bruyns, and Dr. V. Westhoff (Netherlands), Mr. Fairfield Osborn (president of the U.S. Zoological Society and the Conservation Foundation), Mr. Roger Tory Peterson (United States), Mr. Hugh M. Raup (director of Harvard Forest, U.S.A.), Mr. F. N. Ratcliffe (Australia), Prof. L. G. Romell (Sweden), Prof. R. Sparck (Copenhagen), Prof. W. Szafer (Poland), Prof. V. E. van Straelen (Belgium) and Dr. E. B. Worthington (Africa).

A number of directors and other officers of national parks, nature reserves, forests, and interested societies also attended, including: Mr. J. H. Baker (executive director of the U.S. National Audubon Society), Mr. H. H. Bennett (recently chief of the U.S. Soil Conservation Service), Mr. M. C. Bloemers (director of the Netherlands Government Nature Protection Department), Mr. H. J. Coolidge (director of the Pacific Science Board), Mr. R. de Vilmorin (president of the French Société d'Acclimatation), M. F. Edmond-Blanc (secretary general of the Conseil Internationale de la Chasse), M. J-P. Harroy (Governor of Ruanda Urundi), Mr. R. Knobel (director of national parks, South Africa) and M. F. Vidron (secretary general of the Conseil Supérieure de la Chasse, France).

The United Kingdom was represented, among others, by Profs. W. H. Pearsall, P. W. Richards, M. L. Anderson and R. Matthew, and by Mr. A. B. Duncan, Sir Basil Neven Spence, Mr. E. M. Nicholson, Dr. F. Fraser Darling and a number of members of the staff of the Nature Conservancy, and representatives of the National Coal Board, the National Parks Commission, the North of Scotland Hydro-Electric Board, the Forestry Commission, and a number of other public authorities and government departments, together with Lord Hurcomb (president), and other representatives of the Society for the Promotion of Nature Reserves, Mr. Peter Scott (director) and members of the research staff of the Wildfowl Trust, Capt. Keith Caldwell and Lieut.-Col. C. L. Boyle (Fauna Preservation Society), and others.

The meeting was notable in bringing together for the first time picked representatives of so many different professions, whose activities affect land use and management, and who are increasingly feeling the need for a concerted approach to their problems. For this purpose the agenda of the technical meeting consisted of four topics, three of which related to land use:

(1) Management of nature reserves on the basis of modern scientific knowledge. This subject elicited several important papers. Ecologically, one of the most interesting was Mr. Raup's reconstruction, based on nearly fifty years of organized studies by Harvard University, of the relation of present to past woodlands in eastern North America. Briefly, he held that the conception of a stable climax forest is an illusion (even where there is no human interference), and that natural catastrophes, particularly wind-throw during storms, and also fire, occur within the life-span of most trees on most areas—whi climatic and other environmental changes keep t

vegetation from settling down on any one consistent pattern. He compared the process with the similarly drastic effects of frost action on the arctic tundra, and he demonstrated techniques of tracing, through woodland soil profiles, storm havoc going back so far as four hundred years.

Dr. Ira Gabrielson gave an excellent summary of United States techniques in nature reserve management, and Mr. E. M. Nicholson submitted a detailed review of the principles of management of natural areas, based on a comparison between European and North American practice.

Brief mention must also be made of Prof. Romell's valuable analysis of the extensive man-made elements in Scandinavian habitats, and the Wildfowl Trust's review of aspects of the management of wildfowl refuges in Britain.

Mr. Fairfield Osborn presided over these sessions, with Dr. F. Fraser Darling as *rapporteur*. Unfortunately, the number of participants in this section was too large to permit adequate discussion.

(2) The second theme was devoted to an international comparison of the course and repercussions of myxomatosis in rabbits, and a critical review of factors affecting its future development. Mr. F. N. Ratcliffe, who presided, described the ecological consequences of myxomatosis in Australia, and Prof. Bourlière, the *rapporteur*, ably summed up the remarkably consistent experience of different countries, as shown by the papers describing the effects on the French, British and Netherland flora, and on predatory and competing animals, particularly in Britain.

Mr. H. V. Thompson (Ministry of Agriculture, Fisheries and Food) expressed the personal view that in England the rabbit population may, provided there are sustained efforts at control, be held down to roughly a fifth of its level before myxomatosis. The relationship between the more virulent and less virulent strains of the virus, and the considerations affecting possible repeated use of the virus among rabbit populations which have already been attacked by it, were fully reviewed.

(3) The third theme was a return to land-use problems, with special reference to the rehabilitation of areas biologically devastated by human disturbances. Dr. R. Lessing (London) initiated a lively discussion on colliery refuse and mining subsidence. He stated that the present method of surface disposal of colliery refuse means waste, nuisance and damage, and that the National Coal Board will soon be sterilizing nearly 1,000 acres a year, worth between £50,000 and £100,000, by covering it with some 40 million tons of mined refuse containing an estimated fuel value equivalent to that of nearly 10,000,000 tons of coal; much of this could be utilized by the design and installation of suitable plant, which has now been shown to be technically practicable. At the same time, compensation for subsidence resulting from the bringing of this material to the surface is estimated at £3,000,000 a year; this could be prevented or minimized by storage underground of solid material. Naturally these conclusions proved controversial and were in particular criticized by a representative of the National Coal Board. The meeting concluded that, after reviewing a wide range of specialized evidence on the practice, the time has come for all governments concerned to initiate official technical investigations in order: (*a*) to determine whether this type of spoil should not in future be disposed of underground in order to avoid the serious waste of land, fuel and other natural resources which it involves; (*b*) to fix time limits within which either the practice of dumping should cease or the matter should be further reviewed; (*c*) to examine the possibility of dealing by legislation or otherwise with existing spoil heaps of this type.

In contrast, the North of Scotland Hydro-Electric Board was warmly congratulated by delegates for its successful efforts to reconcile hydro-electric development with preservation of amenities, and of the fauna and flora. The Board's work was inspected on the ground during a visit to the Pitlochry and Tummel areas.

The joint consideration by ecologists, engineers, and land planners of a number of problems arising from large civil engineering works produced some of the most interesting discussions, and it was generally agreed that much greater efforts should be made in future to ensure that the knowledge and advice of ecologists were sought at an early stage by governments, and by agencies undertaking works capable of altering the landscape.

The chairman for this theme was Prof. W. H. Pearsall, and the *rapporteur* was Dr. W. Engelhardt.

(4) The fourth, and closely related, theme dealt broadly with the relationship of ecology with landscape planning, with Mr. R. J. Bentham, chief of the Landscape Department of the Netherlands State Forest Service, as *rapporteur*.

Dr. E. H. Graham contributed an important paper on Nature protection as part of land development, based on extensive American experience. Some interesting papers were contributed from Germany on ecological landscape management in torrent catchment areas, and on the protection of Nature in relation to structure of landscape.

Mr. A. Glikson, an architect from Israel, contributed a thoughtful review of the relationship between landscape planning and ecology, and discussions also took place on other aspects, such as the making and use of vegetation surveys, and the part played by shelter belts in land use, on which the discussion was opened by Prof. M. L. Anderson (Edinburgh).

So far as it is possible to summarize in a few words the results of so much diverse discussion, it may be said that a start has at last been made towards creating the long-needed link between ecology and the various technologies, arts and industries concerned in or affecting its application to landscape. Aesthetic, scientific and economic considerations all have to be reconciled in any satisfactory treatment, and hitherto they have been largely isolated from one another. We are still a long way from being able to formulate any theory to reconcile these conflicting approaches; but we can at least now see that the methods in general use to-day fall far short of the best modern practice and are in too many cases producing serious or even disastrous long-term consequences. The first remedial steps must be to educate the authorities and individuals concerned not to cling to a few favoured methods (such as burning of heather, surface dumping of mining refuse, or shooting of predators), but to turn their attention to the desired results (for example, improved grazing, getting rid of unwanted materials, or maintaining game populations) and to rely on trained scientists to find the best methods for getting these results. There is a close parallel here to the role of research in the Defence Services, where again it has been necessary to show that victory only comes from readiness to replace preconceived and cherished methods by newer and more appropriate

ones. World-wide comparisons are particularly fruitful in the conservation field, and they show clearly that even government agencies and large undertakings are still clinging to methods equivalent to the bow-and-arrow stage in warfare. Both the International Union and national conservation agencies will need to be strengthened to find the right answers and to see that they are put into practice. The high technical quality of the Edinburgh meeting and the impressive representation of the various professions concerned gives encouragement to believe that they will not fail.

The meeting was accompanied by an international film week, at which a wide range of films was shown from countries as far apart as India, Japan, the U.S.S.R., South Africa and Canada, illustrating the increasing potentialities of colour films for scientific as well as education and propaganda purposes. The effects of fire, erosion, pollution and destruction of plant and animal life were vividly illustrated. One general comment was that in too many cases the skill and thoroughness exhibited in obtaining the pictures was not yet matched when it came to cutting and editing the material. As a result of these comments, progress in this direction can be confidently expected.

About 180 photographs of mammals, reptiles, birds, insects and plants were exhibited from the British National Collection of Nature Photographs, newly formed by the Nature Conservancy, and the Royal Scottish Museum arranged an interesting exhibition on "Man and the Balance of Nature" which included a good deal of material from the recent International Exhibition organized by the International Union for the Conservation of Nature and Natural Resources in Paris.

The papers and discussions of the technical meeting will be published as soon as possible, but in the meantime the Nature Conservancy would be glad to reply to any inquiries, addressed to it at 19 Belgrave Square, London, S.W.1.

INTERNATIONAL UNION OF CRYSTALLOGRAPHY

MEETINGS IN MADRID

THE meetings of the International Union of Crystallography held in Madrid during April 2–7 were a departure from the previous practice of the Union in several ways. For the first time, the main interest of the symposium was not focused on structure on a molecular scale, but on structure on a scale intermediate between molecular and optical-microscopic. Also for the first time, two of the Commissions of the Union organized an extended series of open meetings. The programme was very crowded, and even with the help of colleagues I am able to give only an incomplete account.

Teaching of Crystallography

The Congress of the Union held in Paris in 1954 saw the beginning of the present general interest in the teaching of crystallography and the establishment of a Commission[1] on such teaching. In preparation for the Madrid meetings, this Commission had circulated a questionnaire, and from the replies and the statements given by several national representatives it was obvious that crystallography, though it grew suddenly out of the morphological stage as long ago as 1912 and has made swift progress since, has not received full academic recognition even yet. Full courses in crystallography at the undergraduate level are extremely rare, and most of the undergraduate teaching given elsewhere is slight and incidental to studies in the older sciences. The best opportunity for serious study of, and training in, crystallography is postgraduate, and the prior training in other subjects is a great advantage. For crystallography embraces a field far wider than is often realized—even by those engaged in other sciences—and far wider than its name suggests. In just over forty years we have gained an insight into the variety of structures, perfect and imperfect, and into the structural reasons for the chemical and physical properties of solids, that far outstrips our knowledge of liquids and gases. This new insight is being rapidly exploited by industry, but scarcely any use has been made of it in modern presentations of the established sciences.

It was generally agreed that, instead of trying to squeeze formal courses on crystallography into the already overcrowded degree courses, it would be both easier and more natural to introduce it incidentally and gradually, thus making the student structure-conscious even from his school days. The preciseness of crystal models and the directness of this approach could transform completely much of the teaching of the basic chemical laws, and at the university degree level could simplify the presentation of material in many subjects. In some subjects, such as physics, the emphasis would be less on the diversity of structures and more on the relations between structure and physical properties (especially anisotropic properties), and on diffraction phenomena in two and three dimensions. Mineralogy has had, of course, the closest academic relation with crystallography, but it is remarkable how many departments still concern themselves mainly with morphological and petrological techniques, paying scant attention to structure and its connexions with geochemistry—and (so it would appear from the discussions in Madrid) even less to the techniques of structure analysis. On this point, contributions at the meeting from the U.S.S.R. were especially interesting. The bias of Russia has been traditionally mineralogical, but for the few who undertake the very extensive courses the training is comprehensive and modern. In Europe generally there is great variety in the approach, and the extent of training is dependent on local educational tradition and personal initiative. In North America there are a very few, and very good, schools of crystallographical research and postgraduate teaching, but very little is done at the undergraduate level. Japan is worthy of mention for the scale and quality of its post-war work in crystallography, but it is not clear how far the subject has penetrated into undergraduate teaching.

The ideas exchanged at Madrid on the order of presentation and on teaching aids were valuable, and showed that, despite the variety of contexts in which the subject is introduced, geometrical concepts are

the most important and usually the earliest topics treated, with crystal chemistry a close second. Crystal physics, except perhaps for crystal optics, is usually a poor third.

There is no shortage of good text-books for the specialist student, but there is an urgent need for the provision of new or revised text-books for college, school and, indeed, general use. These should rely much more on the structural approach to chemistry, physics, metallurgy, mineralogy and biology.

Apparatus

The papers on crystallographical apparatus were mainly concerned with advances in techniques in powder diffractometry and with the development of X-ray tubes and associated equipment. The properties of the various quantum-counting devices used in diffractometry have now been investigated in detail over the X-ray range of wave-lengths, and it appears that the thallium-activated sodium-iodide scintillation counter, used with a pulse-height analyser, has considerable advantages over the Geiger or the proportional counter[2]. The analyser, when set to accept the proper range of pulse amplitudes, is very effective in reducing background from diffuse scattering of the continuous spectrum, from specimen fluorescence, and from radiation other than X-rays. The high quantum efficiency of the scintillation counter, and its uniform response over the range of X-ray wave-lengths normally used, gives it a uniformly high figure of merit (based on equal weights for observed counting rate and peak-to-background ratio), and makes it very suitable for fluorescence analysis as well as for powder and single-crystal diffraction work.

The application of focusing monochromators to the improvement of powder diffractometry has also received a good deal of attention. In one of the more promising arrangements the specimen is used in transmission with a reflecting monochromator placed in the divergent diffracted beam; a standard diffractometer can readily be adapted for this. Though the peak intensity (for values of 2θ between 15° and 85°) is lowered by a factor of about two, the non-characteristic background is eliminated, and the lines are considerably sharper than with the standard arrangement set for maximum resolution. Since preferred-orientation effects are reversed in transmission, this arrangement, in conjunction with the standard one, provides a sensitive means for detecting preferred orientation in a given specimen. In another arrangement the monochromator is placed between the source of X-rays and the specimen, which is examined in transmission. This method has advantages for low-angle work.

The development of fine-focus X-ray tubes has given rise to new problems in the design of both tubes and auxiliary apparatus. A focal spot of ideal shape and brilliance is difficult to obtain, and when a line focus is required, various aberrations arise very readily. The design of line-focus tubes was discussed, and characteristic examples of aberrations and their correction were illustrated. It was emphasized that, to use these tubes to the best advantage, the tube and the diffraction camera need to be designed as a single instrument. A Weissenberg camera with film radius 1 cm., and an axial retigraph with specimen-to-film distance 1 cm., were noteworthy examples. Improvements in the design of rotating-anode tubes were also described.

Single-crystal counter diffractometry continues to develop, and some account was given of an arrangement in which the mechanical precision required is less than in earlier equipment, so that its construction is practicable in small workshops.

Analysis of biological specimens can be carried out on the electron microscope by taking photographs with three different beam velocities; these photographs are used to produce a composite coloured image of the specimen. The different colours are characteristic of the atomic numbers of the elements present and indicate their distribution in the specimen.

A simple analogue computer[3], based on two d.c. bridges, was described. In its general form the machine will give the product of three sine or cosine terms, so that it can be used for calculations of structure factor, Patterson function or electron density, although the computer that has actually been constructed was specially designed for the calculation of structure factors.

Structure

Individual papers in the symposium on structures on a scale between the atomic and microscopic dimensions were of great interest. Perhaps because it was a first attempt to organize a symposium in this dimensional range, it was a little difficult to discern a 'structure' in their order of presentation, and one was left with a somewhat scrappy impression of the field. The most impressive were the papers on proteins and sub-proteins, investigated both by electron microscopy and by X-ray diffraction. There was an interesting group of papers on the structure of collagen, including a demonstration of the equivalence of the results obtained by the two methods. Another group of papers was devoted to viruses[4]. Consideration of the structure of molecular viruses led to some interesting applications of point-groups, including a cubic point group, 532, possessing a five-fold axis[5].

The papers on metals showed extreme diversity, from surface films through tin whiskers to more conventional structure work on phases with very large unit cells. Work on field-emission microscopy[6] was noteworthy. The investigation of structure and structural imperfections in metals at 5° K. was interesting both for its results and for the ingenuity of the apparatus, which provided for cold-working the specimens in the spectrometer at the low temperature.

The work on proteins and metals formed two reasonably consistent groups, although the arrangement of the programme somewhat obscured this. There were, in addition, a large number of papers difficult to classify, on topics ranging from commercial greases to orientation of cellulose in filamentous algae. One was led to wonder if a number of smaller meetings, more restricted in scope, with a single subject only claiming attention at any one time, would not be more valuable than a large conference with several simultaneous sessions.

A. J. C. Wilson

[1] *Acta Cryst.*, **7**, 610 (1954).
[2] Parrish, W., *Philips Tech. Rev.*, **17**, 206 (1956).
[3] Montes Villalón, J., and Abbad, M., *Publ. Inst. Fís. "Alonso de Santa Cruz"*, **7**, 37 (1953).
[4] Franklin, R. E., *Nature*, **175**, 379 (1955); **177**, 928 (1956). Caspar, D. L. D., *Nature*, **177**, 928 (1956).
[5] Crick, F. H. C., and Watson, J. D., *Nature*, **177**, 473 (1956). Caspar, D. L. D., *Nature*, **177**, 475 (1956).
[6] Drechsler, M., and Vanselow, R., *Z. Krist.*, **107**, 161 (1956).

OBITUARIES

Prof. C. van Riet Lowe

THE death of Prof. C. VAN RIET LOWE in Johannesburg, South Africa, on June 17 is a severe loss to archæology not only in South Africa but also to the science as a whole.

Prof. van Riet Lowe trained as a civil engineer at the University of Cape Town, but interrupted his studies to serve with distinction in the First World War, first with the South African Artillery and later with the Royal Horse Artillery, in East Africa, Egypt, Palestine, Italy and France. In 1940 he again donned uniform to take command of the Witwatersrand University Training Corps Battery.

In 1920 he entered the Civil Service as an engineer in the Public Works Department and reached the top of his profession in 1931, when at the age of thirty-seven he became chief engineer of the Department.

During 1923–28 he was in charge of bridge construction in the Orange Free State. He was quick to seize the opportunities this presented for archæological field-work in his spare time. He discovered a large number of Stone Age sites, began the long series of research publications which at the time of his death exceeded 130, and rose rapidly to the forefront of South African archæologists. In 1929 he collaborated with Prof. A. J. H. Goodwin in publishing "The Stone Age Cultures of South Africa", which still is the most comprehensive account of South African prehistory.

In 1935 the Government established the Bureau of Archæology, which later became the Archæological Survey of the Union of South Africa, and van Riet Lowe was the obvious choice as its first director. The University of the Witwatersrand provided accommodation for the new institution and appointed the director to a chair of archæology. At this time, too, the Commission for the Preservation of Natural and Historical Monuments, Relics and Antiques was reconstituted under a new Act of Parliament, and Prof. van Riet Lowe became a member and secretary of that body. He was thus entrusted with building up these new institutions from their beginnings and acquitted himself of all three tasks with great distinction.

Prof. van Riet Lowe's contributions to archæology cannot be reviewed in a brief note. One of his first projects as director of the Archæological Survey was a geological and archæological study of the gravels of the Vaal River, undertaken jointly with the Geological Survey of the Union, which for the first time gave us a climatic sequence and cultural correlation in the south of the continent. A similar study of the Little Caledon River has just been published. He directed the important excavations at Mapungubwe undertaken by the University of Pretoria, and the excavation of the Cave of Hearths in the Makapan's Valley, which proved to contain a complete Stone Age sequence from the end of the Earlier Stone Age to modern times.

He was assiduous in recording and studying the great wealth of prehistoric art which adorns the South African rock shelters, on which he became the leading authority, and welcomed the collaboration of the Abbé Breuil, who was invited by the late General Smuts to join the staff of the Archæological Survey during the Second World War.

Van Riet Lowe travelled widely in the pursuit of his researches. In 1931, when he represented the South African Association for the Advancement of Science at the centenary meeting of the British Association, he made a study of the important archæological collections in England and France and visited many sites in company with such authorities as Burkitt, Henry Balfour, Breuil, Harper Kelley and Henri Martin. In 1937 he undertook a long journey of archæological exploration through Egypt and the Sudan, East Africa, the Belgian Congo and the Rhodesias, and two years later was invited by the Government of Uganda to describe the prehistory of that important territory in collaboration with Mr. E. J. Wayland. This work was published as Part 2 of a memoir of the Geological Survey of Uganda; Part 1 on the Quaternary geology of the area, by Mr. Wayland, is in preparation. He twice paid official visits to Mozambique to advise the Government of that territory on the organization of archæological research and the preservation of monuments.

His long service in many spheres brought him many honours. He was a past president of the South African Association for the Advancement of Science, the South African Archæological Society and the South African Museums Association. He was awarded the South Africa Medal by the South African Association for the Advancement of Science in recognition of his distinguished research, and the medal of the Historical Monuments Commission for his work in that field. He received the degree of D.Sc. from the University of Cape Town and was a Fellow of the Society of Antiquaries and the Royal Society of South Africa. He represented the Government of South Africa on the International Historical Monuments Commission of the League of Nations and later became a member of the International Commission on Monuments of Unesco. He took an active part in the Pan-African Congresses on Prehistory in Nairobi, Algiers and Livingstone and was invited by the Governments of Iraq and Spain to visit their countries.

Dr. C. E. Eddy

CECIL ERNEST EDDY, whose death at the age of fifty-six following a heart attack has been reported from Perth, Western Australia, was one of Australia's best known and best loved scientists. Born in Albury, in New South Wales, he crossed the State border and was educated in Victoria at Colac High School and the University of Melbourne, from which ultimately he received the degree of D.Sc. However, it was to the whole of Australia that Eddy's services were rendered as director of the Commonwealth X-ray and Radium Laboratory since 1935.

Following graduation, he took the M.Sc. degree at Melbourne in 1924 and became research physicist in the Department of Natural Philosophy in 1927. In 1927, also, he was awarded a Rockefeller Fellowship, and studied in England during 1927–28. Cambridge, as was to be expected, left its mark on him, as on many great figures in the world of physics. It is worthy of note that by 1929 Eddy was reporting the use of the Geiger counter for the detection of β-rays transmitted by aluminium. In the next few years, in collaboration with his chief, Prof. T. Laby, he

published in the *Proceedings of the Royal Society* papers on the analysis of materials by means of X-ray emission spectra.

In the 1930's and 1940's Eddy was a not infrequent contributor of articles to the *British Journal of Radiology*. From these can be deduced not only his native interest in the fundamentals but also his administrative acts in introducing methods of modern dosimetry into the Australian practice of radiology.

Indeed, as a scientific administrator, Eddy was outstanding. His battles to bring all that was best in the world to his own country will probably only be known and appreciated there. But in recent years he was to become more widely known in international scientific relations. With the introduction after the Second World War of radioactive isotopes, it fell to Eddy to negotiate abroad for materials and equipment with which Australian physical, biological and medical research could keep in step with the most advanced countries of the world. In the field of personal and public protection against radiations and radioactivity he was an active participant in the deliberations of the International Commission on Radiological Protection, and lately he had represented his country on the committee of the United Nations Organization called on to evaluate the world problem of radioactivity. Of this notable body he was elected chairman; his loss at this stage, after such a successful start of this Committee's deliberations, will be deeply felt.

In addition to his membership of Australian scientific societies, Eddy was a Fellow both of the Physical Society and the Institute of Physics in Britain.

J. F. Loutit

NEWS and VIEWS

Geology in Edinburgh: Prof. Arthur Holmes, F.R.S.

Prof. Arthur Holmes, who shortly retires from the regius chair of geology in the University of Edinburgh, has been distinguished for his contributions in two main fields of his science. In his early days at the Imperial College of Science and Technology, London, his association with Lord Rayleigh led him to pioneer the investigation of the geological implications of radioactivity. Major contributions to the problem of the age of the Earth and to the assessment of the Earth's thermal history have come from his pen; for example, he first directed attention to the importance of potassium as an emitter of radiothermal energy. It is not too much to say that his work revolutionized previous conceptions of geological time and of the history of the Earth. At the same time, he continued the interest in igneous petrology first manifested in his account of his explorations in Mozambique with a series of outstanding studies which have included such diverse subjects as the alkaline igneous rocks of North-west Angola, the Arctic basalts, the Whin Sill and the North of England dykes, the petrography and chemistry of the potash-rich lavas of Uganda, and the origin of kimberlite. He has never been content with mere petrographical description; through all his work there has run the search for a fundamental mechanism capable of producing the diversity of rock types which the Earth's crust exhibits, leading him far in the direction of syntexis and metasomatism under the influence of emanations.

In 1924, Holmes went to Durham as first head of the newly founded Geology Department; there he remained until his translation to Edinburgh in 1943. His great gifts as a teacher and his lucid text-books on petrography and physical geology have made his influence on the science profound and lasting. His later years have been full of honours; he was elected to the Royal Society in 1942; a foreign member of the Royal Swedish Academy of Sciences and of the Royal Netherlands Academy of Science in 1947 and of the Paris Academy of Sciences in 1955. This year he received the Wollaston Medal, senior award of the Geological Society of London, and is to be the recipient of the Penrose Medal of the Geological Society of America.

Prof. F. H. Stewart

Dr. F. H. Stewart, senior lecturer in geology in the Durham Colleges, is to succeed Prof. Holmes in Edinburgh. An Aberdonian, Dr. Stewart was educated at Fettes College, Edinburgh, and in the University of Aberdeen, where in 1937 he gained a first-class honours B.Sc. in geology. Having been awarded the Kilgour Research Studentship, he commenced investigations of igneous petrology under Prof. T. C. Phemister; these he continued at the Department of Mineralogy and Petrology at Cambridge under Prof. C. E. Tilley during 1939–41. He was then appointed to the physico-chemical research establishment of Imperial Chemical Industries at Billingham. Here he became interested in the potash-bearing salt deposits, and began his studies on the cores of Eskdale No. 2 borehole, the first boring to find potassium evaporites in Britain. In 1943 he was appointed lecturer in petrology in the University of Durham, and here the work begun in Scotland and at Billingham has been brought to fruition.

Dr. Stewart is chiefly known in the field of igneous petrology for his study of the layered basic complex of Belhelvie, probably the best example in Britain of a type which includes also the great Bushveld body in South Africa. After completing this work, he began a revision of part of the Tertiary volcano of Skye, which is still in progress. His contributions to the petrological study of the saline deposits have been many and varied, but they have served especially to reveal the numerous and complex mineral substitutions which have taken place in the evolution of potassium-rich zones. The publication of his work on the borings undertaken for Messrs. Fisons around Robin Hood's Bay, Yorkshire, is awaited with much interest. In the meantime, Dr. Stewart's petrological investigations have found recognition in the award of a moiety of the Lyell Fund, by the Geological Society of London in 1951, and of the Mineralogical Society of America Award for 1952. In following Arthur Holmes from Durham to the Edinburgh chair, Frederick Stewart takes with him a broadly-based reputation in mineralogy and petrology; but these subjects do not represent the sum of his interests. His enthusiasm for field geology in all its aspects, his skill as a collector of fossil fishes and his knowledge of ornithology reveal him as a naturalist in the best sense.

Research Medicine, University of Pennsylvania: Prof. Colin M. MacLeod

Dr. Colin M. MacLeod, professor of microbiology and chairman of the Department of Microbiology at New York University College of Medicine since 1941, has been appointed John Herr Musser professor of research medicine and chairman of the Department of Research Medicine of the School of Medicine of the University of Pennsylvania. He succeeds Dr. William C. Stadie, who has been made emeritus professor. A Canadian by birth, Dr. MacLeod is a graduate of McGill University Medical School, and during 1934–41 he was a member of the staff of the Rockefeller Institute for Medical Research in New York. Dr. MacLeod's special fields of interest are infectious diseases, microbial genetics and immunology. He is a member of the Armed Forces Epidemiological Board and was president of that Board during 1947–55. He is a member of the Executive Committee of the Division of Medical Sciences of the National Research Council, and last year was a member of the Special Committee on Medical Research of the National Science Foundation. Since 1945 he has been associate editor of the *Journal of Immunology*. Dr. MacLeod is a member of the U.S. National Academy of Sciences, the American Association of Immunologists (president 1951–52), the Harvey Society (president 1955–56), and the Society of American Bacteriologists, among others.

Hurricane Research in the United States

The Woods Hole Oceanographic Institution, Massachusetts, supported by the United States Weather Bureau, the United States Navy and the Office of Naval Research, is to trace the hurricanes, which bring disaster to the eastern seaboard of the United States, to their birthplace over the ocean. They are formed in summer between about latitudes 5° and 8° N., and so far as is known at present they occur after a period of abnormally light winds across the northern half of the trade-wind belt. The Woods Hole scientists suggest that these conditions lead to unusually high sea-surface temperatures and abnormally high humidity in the lower layer of the atmosphere—probably because fewer sea-salt nuclei are carried up from the surface and less rain is initiated. When there is sufficient instability to produce winds to raise whitecaps, more nuclei will be carried up, and under extreme conditions the condensation, release of latent heat and increased convection will grow into a hurricane.

To make the basic observations and to test such ideas, a 125-ft. ex-coastguard cutter has been converted for research in marine meteorology. In addition to the usual meteorological and upper-air observations, detailed measurements will be made of the temperature and state of the sea surface. The work will be done in close collaboration with an airborne team supplied by the U.S. Weather Bureau. A better understanding of the physical processes which produce the hurricanes will facilitate prediction, and there is a hint in the plans that it may be practicable to prevent the formation of a large organized disturbance by using rain-making techniques at scattered points before the conditions become critical. The new research ship *Crawford* carries eight scientific workers and a crew of fourteen. She carries supplies for a month, and fuel for 6,000 miles at 12 knots. She sailed from Woods Hole for the hurricane-generating region on July 3.

Atoms in Industry

P.E.P. (Political and Economic Planning) has recently issued two pamphlets entitled "Atoms in Industry", which provide an excellent appreciation of the British nuclear power plan and of the problems associated with its implementation. The first pamphlet gives estimates drawn from recent publications of the probable cost of the electricity to be generated in the early gas-cooled, graphite-moderated stations; deals with the increased importance relative to coal-fired stations of capital costs and the likely impact of the operation of sources of nuclear power on the national economy; and outlines the organization of the United Kingdom Atomic Energy Authority and its present and possible future relationship to manufacturing industry. The second discusses the factors governing the location of nuclear-power stations and the safety and insurance of these stations; and summarizes the steps which are being taken to establish effective international co-operation. It also incorporates a section dealing with radioactive isotopes, the techniques and economics of their application in industry, and the arrangements which the Atomic Energy Authority has made for their exploitation. It is stated in the conclusion that the account has been written strictly in the context of the present state of commercial developments, so that no attempt has been made to outline and compare the more advanced forms of power reactor which may emerge as alternatives to the gas-cooled, graphite-moderated type within the next decade, or to consider the prospects of nuclear propulsion.

The pamphlets will be found useful both by those directly concerned and those to whom developments in the peaceful utilization of nuclear energy are only of general interest. They would have been even more valuable to both classes of reader, however, had attention been given to the extent to which these developments may be hampered by the present shortage in Britain of scientists, technologists and technicians, as was made very clear in an article in *Nature* of December 24, 1955.

Technical Education and Industry

The Federation of British Industries has issued a memorandum welcoming the White Paper on Technical Education but is reserving overall appraisal until the universities have published their plans for technological education for the quinquennium 1957–62, pointing out that account must also be taken of the 'bulge' in population which now has its peak among those entering the secondary schools. In the view of the Federation, the plans are not specific enough. No attempt has been made to specify the time within which the proposed increases in the numbers of technicians and technologists is to be achieved, nor is it indicated how the Government proposes to secure the essential co-operation from the public, parents, teachers and industry. While suggesting curtailment of the development of new colleges of advanced technology in the London area, the Federation appears to accept the Government's target figure and merely queries the distribution. It emphasizes the value of co-operation between industry and technical colleges at the level of the governing bodies, but stresses also the value of advisory committees of industrial specialists and teachers. The White Paper is regarded as too complacent in regard to the recruitment and training of

teachers; but while calling for concrete Government plans in this field, the Federation's memorandum gives little indication of concrete support from industry in the release of staff for part-time teaching. The Federation regards the day-release system as a valuable method of providing further training for potential technicians and technologists, and urges its member firms to increase the volume of day-release for this purpose. It agrees that many women could be trained in technological subjects, and holds that industry provides ready openings for women who are technically qualified on appointment. The adoption of 'sandwich' courses by more firms is urged, and such courses are discussed in some detail, particularly in regard to the importance of background information, co-operation between technical colleges and firms, amenities, finance, and the relevance of the proposals of the National Council for Technological Awards.

International Council of Museums: Conference in Switzerland

The fourth general conference of the International Council of Museums was held in Switzerland during July 2–9 under the presidency of Dr. George A. Salles, director of the French museums. Some 250 delegates from more than thirty countries attended, including at least four from Great Britain. The conference was held in Basle, Zurich and Geneva, and French and English were used as the working languages. Working groups dealing with specified subjects replaced the usual lectures and discussions. Dealing mainly with display and museum technique, this arrangement was eminently satisfactory and stimulating to those who took part. This was especially the case where broad principles of museology were discussed rather than when a particular exhibit or room was the subject for the working group. A series of five public lectures was delivered under the central theme of "The Museum in our Time". These were given by Dr. George Salles, Sir Gavin de Beer, Dr. Bengt Thordeman, Dr. Karl Bassler and Mr. Francis Taylor. The programme of lectures and working groups was liberally interspersed with visits to museums and to art galleries and receptions with very generous hospitality. The International Campaign for Museums, to be held in the week commencing October 8 next, was formally proclaimed by M. André Leveille, director of the Palais de la Découverte, Paris, and it was decided to hold the next conference in 1959 in the Scandinavian countries with headquarters in Stockholm.

Products of Starch Hydrolysis

Messrs. Vittorio, Krotkov, Nelson and Bidwell have examined the products of starch hydrolysis and their metabolism, using tobacco leaves in which the starch content is very high after photosynthesis (*Canad. J. Bot.*, **34**, No. 2, 209; 1956). Carbon-14 labelled tobacco leaf starch, digested with *N* sulphuric acid in a boiling water bath, was not completely hydrolysed to glucose even after 24 hr. After three hours hydrolysis, paper partition chromatography with butanol–ethanol–water solvent revealed that besides glucose there were four carbon-14 labelled products with R_F values lower than glucose. When these bands were fed individually to tobacco leaves in light, they were incorporated into sucrose, glucose, fructose and starch, and were better starch formers than glucose, glucose-1-phosphate or maltose.

Tropical Tuna Resources of the Eastern Pacific

The tropical tunas which inhabit the high seas off the shores of the Americas from California to Peru and northern Chile support the most valuable fishery of the eastern Pacific Ocean. This consists of populations of two species, the yellow-fin tuna, *Thunnus* (*Neothunnus*) *macropterus*, and the skipjack (barrelete), *Katsuwonus pelamis*. In 1953, 140 million pounds of yellow-fin and 134 million pounds of skipjack were produced from the eastern Pacific. The preponderant share of the catch is taken by fishing vessels based on the west coast of the United States—very modern, long-range craft forming one of the most specialized fishing fleets in the world. A small but appreciable share of the catch is taken by vessels based in Peru. Most of the landings in countries other than the United States are transhipped frozen to the United States for processing as canned tuna. A scientific investigation of the tuna resources of this important fishery has been undertaken by the Inter-American Tropical Tuna Commission. A description of its work was given by its director, Milner B. Schaefer, at the United Nations conference in Rome during April 18–May 10, 1955, dealing with the Conservation of the Living Resources of the Sea.

Effects of Radiation on Dielectric Materials

A conference on "The Effects of Radiation on Dielectric Materials" was held at the United States Naval Research Laboratory, Washington, D.C., during December 14–15, 1954, under the joint auspices of the Naval Research Laboratory and the Office of Scientific Research of the Air Research and Development Command, and the report of the proceedings has recently been published (No. PB111863; pp. 169; Washington, D.C.: Office of Technical Services, Department of Commerce, 1956; 4.25 dollars). The object of the conference was to provide an exchange of information on the research programmes and progress of the various laboratories engaged in the study of the effects of radiation, and also to examine and discuss the general aspects of the wide variety of disciplines involved in this field of investigation. Representatives of many United States government laboratories and of university and industrial laboratories participated in the conference, and survey talks on various aspects of radiation effects were delivered by Drs. M. Burton (Notre Dame University), R. Smoluchowski (Carnegie Institute of Technology), K. H. Sun (Westinghouse Electric Corporation) and D. Billington (Oak Ridge National Laboratory). The article by Dr. Sun, entitled "Effects of Atomic Radiation on High Polymers", is particularly valuable because of its extensive bibliography, compiled by F. A. Pecjak and the author, which consists of 217 references. The proceedings consisted of four sessions, and twenty-one papers were presented. They include, in addition to the survey talks, a description of research and radiation effects in insulating materials carried out at the Brookhaven National Laboratory; "Radiation Effects on Glass", by N. J. Kreidl (Bausch and Lomb Optical Co.); and several discussions of the effects of atomic radiation on polymers, including polyethylene and 'Teflon', at low temperatures, and of general radiation on crystals, including diamond.

University of Leeds: Gifts

The following gifts have been received by the University of Leeds: £2,000 from an anonymous

member of the Clothworkers' Company to the Department of Biomolecular Structure, to be devoted to the furtherance of cancer research carried on under the direction of Prof. W. T. Astbury; £2,000 from the Central Electricity Authority to the Department of Agriculture, to continue during 1956–57 research on the reclamation of ash lands; £6,000 a year for two years from the Nuffield Foundation to the Department of Medicine, in support of the gerontological research unit.

Institution of Electrical Engineers: Officers

THE following will take office on the Council of the Institution of Electrical Engineers on September 30 next: *President*, Sir Gordon Radley; *Vice-Presidents*, T. E. Goldup, S. E. Goodall, Dr. Willis Jackson, G. S. C. Lucas and Sir Hamish D. MacLaren; *Honorary Treasurer*, Rt. Hon. Viscount Falmouth; *New Members of Council*, J. A. Broughall, B. Donkin, A. H. Mumford, D. P. Sayers, H. Watson-Jones and H. West.

The Night Sky in August

NEW moon occurs on Aug. 6d. 11h. 25m., U.T., and full moon on Aug. 21d. 12h. 38m. The following conjunctions with the Moon take place: Aug. 3d. 13h., Venus 3° S.; Aug. 7d. 22h., Mercury 6° N.; Aug. 8d. 03h., Jupiter 6° N.; Aug. 13d. 21h., Saturn 3° N.; Aug. 23d. 21h., Mars 12° S. In addition to these conjunctions with the Moon, Mercury is in conjunction with Regulus on Aug. 5d. 04h., Mercury 0·9° N., and is also in conjunction with Jupiter on Aug. 9d. 18h., Mercury being then only 0·2° S. of Jupiter. Mercury is too close to the Sun for observation during August. Venus rises at 1h. 35m. at the beginning of the month and at 1h. 15m. at the middle and end of the month; its stellar magnitude varies between −4·2 and −4·4 and the visible portion of its illuminated disk increases from 0·297 to 0·492, its distance from the Earth increasing from 44 to 65 million miles. Mars rises at 21h. 45m., 20h. 50m. and 19h. 50m. on August 1, 15 and 31, respectively, and during the month its brightness increases in magnitude from −1·8 to −2·5, the visible portion of its illuminated disk increasing from 0·930 to 0·991 and its distance from the Earth decreasing from 43 to 35½ million miles. Jupiter is too close to the Sun during August for favourable observation. Saturn can be observed for a short time after sunset, its times of setting being 23h. 25m., 22h. 30m. and 21h. 30m. at the beginning, middle and end of the month, respectively; its stellar magnitude remains about 0·7, while its distance from the Earth varies from 896 to 942 million miles. It has a slow eastward movement in Libra, and at the end of the month it is about 5° south-east of γ Libræ. The Perseid meteors attain a maximum about August 10–13, the radiant being at R.A. 3h. 8m., Dec. 58° N.

Announcements

THE Scottish Agricultural Industries, Ltd., post-graduate studentship at the University of Aberdeen has been awarded to R. Bain, who will work on the sorption of polyelectrolytes on mercury and on clay mineral surfaces.

THE Alvarenga Prize for 1956 of the College of Physicians of Philadelphia has been awarded to Dr. George N. Papanicoloau, director of the Papanicoloau Research Laboratory of Cornell University Medical College, for his outstanding work in the early detection of cancer.

DR. ALBERT H. MOSEMAN, formerly director of crops research in the United States Department of Agriculture Research Service, has been appointed associate director for agriculture of the Rockefeller Foundation. Dr. Moseman's activities will be associated with Foundation grants to institutions in the United States for fundamental research in agriculture, and agricultural programmes in foreign countries. He will work in association with Dr. J. George Harrar, director for agriculture.

THE University of Oxford has received from the Medical Research Council a grant of £3,655 for the continuation of research into the effects of the injection of radioactive substances being carried out in the Nuffield Department of Medicine by Dr. J. M. Vaughan, principal of Somerville College, and £2,000 for the equipment of a hutted laboratory for use by Dr. Vaughan.

THE Chemical Research Laboratory, Teddington, will hold its open days this year on October 2 (afternoon only) and October 3–4. Applications for tickets should be made to the Director before August 31. Those already on the mailing list need not re-apply.

THE second of the congresses on theoretical and applied mechanics, sponsored by the Council of Scientific and Industrial Research, India, will be held during October 15–16 in the National Physical Laboratory, New Delhi, under the presidency of Sir K. S. Krishnan. Research papers may be contributed on any of the following topics: elasticity, plasticity and rheology; fluid mechanics (aerodynamics and hydrodynamics); mechanics of solids (ballistics, vibrations, friction and lubrication); statistical mechanics, thermodynamics and heat transfer; mathematics of physics and mechanics, and methods of computation. Such papers, with three copies of abstracts, must be sent before August 15. All correspondence should be addressed to the secretary-treasurer of the congress, Dr. B. R. Seth, Indian Institute of Technology, Kharagpur.

THE Society for Water Treatment and Examination will hold its autumn meeting in the Wills Hall, University of Bristol, during September 19–21. In view of the great interest shown as a result of the publication of the third edition (1956) of "The Bacteriological Examination of Water Supplies" (Report No. 71), the Society will hold another meeting in London on November 20 (5.30–8.30 p.m.) in the Library of the Royal Society of Health, to which the Society of Applied Bacteriology, the Microbiological Section of the Society of Chemical Industry and the Institution of Water Engineers have been invited. Further information on both these meetings can be obtained from the honorary secretary of the Society, A. W. H. McCanlis, 41 Carshalton Road, Sutton, Surrey.

THE Department of Medical Chemistry of the Australian National University (with Prof. Adrien Albert in charge) will be transferred from London to the newly built John Curtin School of Medical Research in Canberra on August 10.

ERRATUM. In a communication entitled "Dependence of Snowfall on Temperature", by L. W. Gold and G. P. Williams, in *Nature* of June 16, p. 1137, it was erroneously implied that Prof. M. Bossolasco correlated frequency of occurrence of snowfall with mean daily temperature; in fact, his correlation was between frequency of occurrence of snowfall and the temperature at the time of fall.

PHYSICS IN MODERN CHINA

By Dr. E. H. S. BURHOP
University College, London

IN the intensive efforts now being made to transform China from a technically backward to an advanced industrial nation, great stress is being placed on the training of scientific and technical personnel. During the course of a recent visit, I therefore took the opportunity to visit universities and scientific institutes and to discuss with Chinese scientists the methods of training employed and the problems being faced. The visit was too short to allow more than a superficial view of the present condition of Chinese science and education; but many of their proposals and practices in this field are so novel that a short account may be of interest.

The impressions reported here were gained in visits to the University of Peking, to Fu Tan University in Shanghai, and to the large technical Tsinhua University in Peking, which seems to be modelled on the Massachusetts Institute of Technology. The same general pattern exists in other Chinese universities, all of which are under the jurisdiction of the Ministry of Higher Education.

The general pattern of student life in the three centres showed many similar features which are also common to other Chinese universities. Entry to a university is determined as a result of a nation-wide competitive examination. There are no fees, and about 60 per cent of the students receive stipends. Payment of a stipend appears to be determined by the financial resources of the student and his parents. The stipend is only small—an average of 12 yuan (about £2) a month—but was said to be sufficient for board and lodging in the hostels in which the students live. A certain number of adult students, who have entered the universities by other routes, receive special stipends of 30 yuan a month, while research students receive between 20 and 30 yuan a month.

Salaries of university staffs vary from 60–90 yuan a month for assistant lecturers, 90–150 for lecturers and 150–200 yuan a month for associate professors and professors. At the Oil Technology Institute of Tsinhua University the numbers of staff in these three categories were 212, 70 and 38, and we were told this was a typical distribution among the different grades.

According to our informants, the basic cost of food for a man, his wife and two children is about 50 yuan a month, while rent of an apartment, together with water and electricity, may require an additional 10 yuan a month. University salaries appear modest if one relates them to the current exchange-rate (6·8 yuan to the pound); but in terms of purchasing power it seemed, from personal observation, that the yuan was much undervalued in relation to the pound. University salaries are being steadily increased—by about 30 per cent during the present five-year plan.

I was particularly interested in the methods of training of physicists, of whom the University of Peking is at present training about two hundred every year, after a four-year course. The whole training of physicists throughout the country is, however, being reorganized, and a five-year course is being introduced, based on a system that has been in use in the Soviet Union for some time, but adapted to Chinese traditions. Within the next few years, the annual entry of physics students to the University of Peking will increase to four hundred, and they will each do a five-year course. At the conclusion of the twelve-year plan, the universities of China will be training seven thousand physicists a year, all of whom are to have completed this five-year course.

With such an ambitious training programme, one might think that the standard of the courses would suffer; but there seemed no evidence of this at the universities visited. The standard now reached in the final year of the four-year course appears to be similar to that of special-degree students in their final year in Great Britain. When the fifth year is introduced, the standard attained will be considerably in advance of

Table 1. Hours per Week devoted to Different Subjects during the Five-year Physics Course

Subject	Semester No. 1	2	3	4	5	6	7	8*	9	10†
Physics (general survey)	5	5	6	6	3					
Practical physics	4	4	4	4	6	5				
Mathematics	10	10	8	5						
Chemistry		3	3							
Theoretical mechanics				4	4					
Methods of mathematical physics					5	5	4			
Thermodynamics and statistical physics					3	4				
Electrodynamics						4	3			
Quantum mechanics							4	4		
Mechanical drawing	3									
Radio engineering					3					
Theory of education							3			
Methods of teaching physics								4		
Experimental techniques in physics										
Special topics‡						4	4	6	10	
Experiments on special topics							6	6	6	
Russian	4	4	4	4						
Marxism—Leninism	3	3	2							
History of Chinese Revolution				4	4					
Political economy						4	4			
Dialectical and historical materialism								5	5	
Physical education	2	2	2	2						
Total hours per week	31	31	29	29	28	26	28	25	21	

* The eighth semester is of twelve weeks duration only. For six weeks at the end of this semester students do workshop practice and other technical work in factories or institutes.

† During the tenth semester the whole time is spent on practical work for the thesis topic.

‡ Courses on the following special topics are offered at the University of Peking: theoretical physics, electronics, optics and spectroscopy, solid state physics, history of physics.

that reached by British first-degree honours students. In their final year, the students are required to carry out advanced practical work of a semi-research nature, and to write a dissertation. Some of this practical work being carried out in Peking included a number of studies on the Hall effect, magnetic domains, the measurement of the refractive index of gases using an interferometer method, the study of beta-ray spectra using a cloud chamber with magnetic field, and several X-ray crystallographic studies. One of the final-year theoretical physics students said he had just written his dissertation on the influence of detailed well-shape in the 'cloudy crystal' nuclear model.

The curriculum of the proposed five-year course is set out in Table 1. Each year is divided into two semesters of eighteen weeks and seventeen weeks duration, respectively, and the table shows the time devoted to the study of various subjects.

An impressive feature of the instructional system is the care taken of the student as an individual. During the first two or three years of his course, a member of staff acts as tutor to a student, guides him in his course and has the task of teaching him how to study. The supervisor must also ensure that no student spends more than fifty-four hours a week in all studies, including home study. In the fourth and fifth years, the students are organized into groups, under a student group-leader.

From the third year onwards, 'term papers' are set which involve the preparation of answers based on the reading of original papers, and the student is expected to spend about twenty-four hours in each semester working on them. In this way, experience is gained in the use of reference libraries, and the student, by the time his fifth year is reached, should be in a position to work on the problem set for his thesis.

Great care is devoted to the examination of students. All university examinations, including the final, are oral. Each year, three weeks in the first semester, and four weeks in the second, are devoted to oral examining of students. Just prior to the examination, the student draws a number of questions he will be expected to answer from a hat. He then has half-an-hour in which to collect his thoughts and consult references before presenting himself for the actual examination, which is carried out by the teacher who took the course and which may last 20–25 min. This system, which closely follows the procedure long in use in Soviet universities, appears to be working quite satisfactorily. More than 80 per cent of all students examined receive the classification 'excellent' or 'very good'. At the end of his course the student is required to defend his thesis at an oral examination.

This examining imposes a considerable burden on the teaching staff; indeed, owing to the shortage of teachers, those able to teach have had to do so for much longer hours than is desirable. The supply of good university teachers is one of the most difficult problems that is being faced. Now that the first generation of students is graduating, however, some of whom will be offered university teaching posts, it is expected that the strain of excessive teaching will be greatly reduced. Indeed, university teachers have been promised that in future it will be regarded as normal for 25 per cent of their working time to be spent on teaching, the remainder being devoted to research.

Some research in solid-state physics and in crystallography was being carried out at the universities visited; but in this connexion, our visit to the Nuclear Physics Section of the Physics Institute of the Academia Sinica was of greater interest. Although it has been operating for only a few years, it has a staff of more than a hundred scientists and technicians, and work was proceeding with the development of most of the modern techniques used in nuclear physics. There was, for example, a cloud chamber, of diameter approximately 25 cm. with a magnetic field of 10,000 gauss, and a multiplate chamber 50 cm. square which had been operated for two years at mountain altitudes. About 50,000 pictures had been taken with it, and some examples of associated production of hyperons and K-mesons, as well as other interesting events obtained. The quality of the work was impressive.

A pressurized Van de Graaff machine, together with acceleration tube to yield particles of energy 2 MeV., has been constructed, together with a high-tension generator employing a Cockcroft–Walton circuit. For work on beta-ray spectroscopy, a two-lens spectrometer has been constructed. A large group was working on problems of the production and use of scintillation counters, while another group was using nuclear emulsions which they themselves had made. Although not as good as the Ilford Company's electron-sensitive emulsions, plates had already been produced which were able to detect particles of twice minimum ionization.

Many of the present workers at the Institute have been trained in Europe or the United States and are well informed about new developments. But more physicists are greatly needed at the Institute and throughout the country. It says something for the insistence on quality of training that, faced with this position, resort has not been made to dilution of courses; and in the research work in nuclear physics, too, great stress is being placed on building a sure and solid foundation so that eventually one may expect work of the highest quality to issue from the Institute.

The scientific problems of China are immense. But they are being approached with such energy and intelligence that there seems little doubt that the China of the future will have much to contribute to world science.

STUDY OF FERTILITY

THE seventh annual conference of the Society for the Study of Fertility was held during June 14–15 at the meeting house of the Zoological Society of London and at the National Institute for Medical Research. Eighteen papers were read, and nine of these dealt chiefly with clinical aspects of human infertility. The remaining nine papers were of more general scientific interest and were communicated by the following investigators.

Dr. J. W. Goldzieher (San Antonio, Texas) described recent work on stallion semen at the South-west Foundation for Research and Education, in which it was found that the semen from some infertile stallions contained apparently normal spermatozoa. Further investigation showed that the motility and fertility of spermatozoa depended as much upon properties of the seminal plasma as upon the vitality of the spermatozoa themselves, and that the quality of the plasma varied greatly between different animals. This was demonstrated by separating the cells from the plasma by centrifugation and then suspending the spermatozoa from one

stallion in the plasma from other stallions. Seminal plasma from some animals supported motility better than that from others, and this property was inversely related to the concentration of sulphydryl compounds. The incidence of pregnancy also was inversely related to the concentration of these substances in the semen.

Dr. J. Hammond (Cambridge) reported investigations on the degeneration of fœtuses during the later stages of pregnancy in the rabbit. The occurrence of fœtal atrophy and the proportion of fœtuses lost were evidently related to a maternal character that could be selected for by appropriate breeding experiments. The inheritance of the character took place in the manner of a genetic recessive and found more obvious expression in animals in which larger numbers of eggs were shed. There was evidence for the operation of the same mechanism in sheep when the number of eggs shed was increased by the administration of hormones. Dr. Hammond believes that fœtal atrophy is not a reflexion of limited space within the uterus but can be ascribed to the relative deficiency in the uterus of some substance required for normal fœtal development. The nature of the substance is as yet unknown.

Dr. A. Walton (Cambridge) described an apparatus developed in collaboration with Mr. H. M. Dott wherein a semen sample is held within a 'Cellophane' tube around which an artificial medium can be circulated. The properties of the medium can be varied at will so that the influence upon the spermatozoa of temperature, hydrogen-ion concentration, gas tension and diffusible substances can be studied without the need for dilution of the spermatozoon suspension directly with the artificial medium. When spermatozoa derived from the epididymis were placed in the apparatus, it was possible to show that the initiation of motility was due to the presence of both oxygen and fructose in the surrounding medium. The effect of the accessory secretions could be ascribed to their content of these substances. Nitrogen inhibited the motility and this inhibition could later be reversed by supplying oxygen.

Dr. I. G. White (Sydney) gave an account of investigations on the effect on spermatozoon motility of composition of the medium, concentration of spermatozoa, and temperature. The buffering of diluting media was particularly important under anaerobic conditions owing to the production of lactic acid. The output of lactic acid varied with the amount of phosphate present, because high concentrations of phosphate decreased the ability of the spermatozoon to oxidize lactic acid. Potassium tended to improve motility, and traces of copper and iron were probably not detrimental. Most chelating agents tested were toxic; cobalt decreased the toxicity of some. The 'dilution effect' was referable to the loss of substances from the spermatozoon, and these may include biotin and cytochrome *c*. The presence of lipo-protein in egg-yolk mitigates the loss. 'Cold-shock' was associated with a drop in the adenosine triphosphate content of the spermatozoon. Some protection was afforded by egg-yolk owing probably to the presence of lecithin and similar compounds. Antibiotics were in general well tolerated by spermatozoa. When spermatozoa were rewarmed after deep-freezing, some metabolism of the added glycerol occurred under anaerobic conditions. Ram semen contains 1 or 2 per cent of glycero-phosphatyl choline.

Miss Clare Harvey (Exeter) said that detailed and systematic examinations of early and late fractions of human semen showed that the early fraction, though often very small, contains the majority of the spermatozoa. She believes that in the pre-ejaculatory phase of excitement a dense mass of fresh spermatozoa passes into the vas deferens and ampulla, where it is met by back-flowing prostatic secretion. The seminal vesicles then discharge, washing the rest of the spermatozoa through the ejaculatory duct. The function of prostatic citric acid in man may be to inhibit coagulation and permit the ready escape of spermatozoa in the female tract, and the function of coagulation in the late fraction may be to prevent dilution of the early fraction.

Mr. G. A. Harrison (Liverpool) reported that mice kept in a hot environment (dry bulb 90° F., wet bulb 84° F.) bred normally; but the females failed to suckle unless they had been brought up under the same conditions. There was thus evidence of adaptation to the high temperature. Adapted animals also survived longer when exposed to temperatures (dry bulb 104° F., wet bulb 84° F.) that generally proved fatal in about 12 hr. Survivors from such an experiment also showed no loss of fertility. Rats exposed to a dry-bulb temperature of 100° F. suffered little or no damage to the testis. When water at 107° F. was applied to the scrotum the testis temperature became constant at 103° F. An environmental temperature of 107° F., however, did not raise the testis temperature above 96° F., although the abdominal temperature was 102° F. The scrotum is therefore an important and efficient heat-disposing surface. This property was removed by covering the scrotum with paint, whereupon an environmental temperature of 100° F. led to testicular damage.

Mr. J. H. Grant (Liverpool) said that he had studied the effects on the remaining testis of unilateral castration in rats. Following the operation, there was a compensatory increase in the growth-rate of the testis, and the final volume reached was greatly in excess of normal. The total number of tubule cells, however, was not increased, nor was the amount of interstitial tissue. The ratio of the diameter of the lumen to the diameter of the whole tubule was also unchanged. The larger size reached by the testis is therefore imputed chiefly to hypertrophy of the tubule cells, although the Leydig cells, after an early decrease, did show some increase in number. Testosterone administration was found to inhibit the testis hypertrophy if applied in the first five weeks after the operation.

Prof. R. G. Harrison (Liverpool) described experiments in which solutions of chorionic gonadotrophin were injected into mature rats. In a control series, rats received injections of sterile distilled water. No effect was seen in the tubular epithelium, in the number of Leydig cells or in the amount of interstitial tissue; but there was an increase in the quantity of tissue fluid. 'Phytoid' vacuoles appeared in the spermatogonia, connoting an increase in cell fluid, and there was enlargement of spermatocyte nuclei. In addition, spermatogonia appeared to be reproducing spermatogonia in large numbers, for several layers of these cells were observed. These changes were seen in both experimental and control groups of rats and are interpreted as evidence of a stress reaction evoked by the injections.

Dr. M. W. H. Bishop (London) gave a short account, illustrated by colour transparencies, describing the application of fluorescent dyes, notably acridine orange, to the study of morphology in living spermatozoa. When the preparations are subjected

to ultra-violet irradiation the spermatozoa exhibit a brilliant fluorescence, the acrosome appearing red or orange and the rest of the cell green. The large variations in the form of the acrosome in several species of mammals were thus clearly demonstrated. With the dye primuline a striking colour contrast is obtained between living and dead spermatozoa.

Demonstrations provided by the Division of Experimental Biology at the National Institute for Medical Research illustrated aspects of work on mammalian gametes and fertilization, reproduction in mice after ablation of the thyroid by iodine-131, gonadal grafts in the rat, production of aspermatogenesis in the guinea pig with testis antigen, and the effects on fœtal development of exposure of the mother to severe hypothermia.

C. R. AUSTIN

EFFECT OF VARIOUS STIMULI ON TISSUES OF DIFFERENT AGES

A MEETING of the British Society for Research on Ageing was held at the Ciba Foundation, London, on June 8, and a series of papers dealing with the effects of various stimuli on tissues of various ages was read.

The initial three papers were introduced by Prof. K. J. Franklin, under whose direction the work had been carried out. In the first paper, Dr. Sheila B. Carter, of the University of Bristol, dealt with the reaction of the gingival epithelium to friction in rats at different ages. She pointed out that, although some human experiments have been carried out in this field, work on animals may be more satisfactory since they may be kept on a standard diet under standard conditions and the amount of friction applied can be controlled. Dr. Carter used the merion rat (*Meriones libycus*) and three experimental groups: 5–4 months old; 9–12 months; and 14–16½ months. In all groups the gum of the diastema between incisors and molars of the right side of the upper jaw was rubbed with a brush consisting of a single nylon tuft about 4 mm. long, for one minute twice daily for 4 weeks, the other side of the jaw being left as a control. The thickness of the cornified layer was afterwards measured in histological sections of the gum. The minimum width of the epithelium and the depth of the epithelial papillæ were also measured. The brushing caused a marked though variable increase (5–280 per cent) in the thickness of the cornified layer. At the same time, the minimum width of the epithelium tended to increase though not significantly; but there was a significant increase in the depth of the epithelial papillæ. It was of interest that there was no correlation between age and any histological change.

It is hoped to extend this work to a study, in the Physiology Department of St. Bartholomew's Hospital Medical College, London, of the clinical effects of mechanical friction on the human gum, and in this connexion Dr. F. J. Aumonier gave an account of his preliminary studies of the human gum. He demonstrated a striking variability in the pattern of the epithelium in human jaws which varied enormously from one side to the other in the mouth, at various levels near the teeth and in the projections of gum between the teeth. Before these clinical studies can be commenced, therefore, a very full study will have to be carried out on the variations in average thickness of gum, minimum and total thickness of the cornified epithelium, resistance to infection, etc., of the human gum in different parts of the mouth.

Dr. Patricia Lindop, of the Nuffield Gerontological Unit at the Department of Physiology, St. Bartholomew's Hospital Medical College, described three pilot experiments used in the study of the roles of whole organs in the process of ageing. The first of these dealt with the rabbit kidney, which was studied in relation to the weight of tissue and blood content at various ages. The latter was determined by using a perfusion method—washing out red cells which had been labelled *in vitro* with radioactive phosphorus. The renal blood content was determined within an accuracy of 2 per cent, and was found to be remarkably constant for animals of the same proportionate weight of renal tissue. In the rabbit Dr. Lindop also demonstrated that there is a distinct correlation between the weight of renal tissue and the whole body weight—that is, the smaller the animal the larger is the proportion of renal tissue. The normal renal blood content shows a parallel decrease ranging from 50 per cent in the neonatal period to 41 per cent between weaning and puberty, and thereafter 31 per cent in adult life with no definite decrease even at three years.

The second experiment carried out by Dr. Lindop was a study of the uptake of radioiodine in 246 rats of different ages (1 day–47 weeks old). No significant difference in rate of uptake nor in the total amount of iodine taken up by the gland was recorded, although if older animals had been studied a change might have been found.

In the third series, eighty-five elderly patients between sixty-five and ninety-five years of age were studied in relation to their renal function following a period of hypotensive anæsthesia for prostatectomy. The aim of this study was to determine whether hypotension with vasodilatation, as occurs with vasomotor paralysis, is less harmful to the senile patient with reduced cardiac, cerebral and renal reserves than hypotension with vasoconstriction occurring during hæmorrhage at operation. It was found that a fall in blood pressure to a level of 80 mm. (of mercury) systolic was optimum. There was no impairment of renal function unless the pressure was dropped below 60 mm., when there was a transient oliguria and a rise in blood urea post-operatively.

The final paper was read by Dr. Honor B. Fell, who pointed out that early work had shown that vitamin A deficiency had caused mucous membranes to undergo a squamous metaplasia and to keratinize. Previous work by Dr. Fell and the late Sir Edward Mellanby had shown that, whereas epidermis from the trunk and limbs of 6–7-day chick embryos differentiated into squamous keratinizing epithelium in a normal medium, it formed a mucus-secreting, often ciliated, membrane when grown in medium to which excess vitamin A had been added. Dr. Fell then went on to describe experiments designed to discover whether explants of older, more highly developed, skin would undergo similar transformation in response to excess vitamin A. The scaly skin of the shank and feet of 13- to 18-day chick embryos was used.

When grown in normal medium, the 13-day skin keratinized and maintained its normal structure; but in the presence of excess vitamin A, it underwent mucous metaplasia as readily as the 7-day epidermis. The 18-day skin had a fairly thick stratum corneum when first explanted; in normal medium the keratin increased in thickness, but in the high vitamin A medium it became detached by swelling and sub-

sequent disintegration of the upper layers of epidermal cells. The deepest, least-differentiated cells survived, and scattered excretory cells and sometimes areas of true metaplasia appeared in this region; metaplasia was less frequent and usually less extensive than in explants of 13-day skin. When transferred from high vitamin A to normal medium, both the 13- and 18-day skin eventually reverted to the squamous keratinizing type. Dr. Fell suggested that, in the organ cultures, the skin was subjected to conditions which probably could not be reproduced in the intact animal; thus experiments *in vitro* with excess vitamin A involved developmental potentialities which perhaps could not have been demonstrated *in vivo*. G. H. Bourne

PHYSICAL STRUCTURE AND ENGINEERING PROPERTIES OF CONCRETE

T. C. POWERS, who is in charge of fundamental research on the properties of concrete at the laboratories of the American Portland Cement Association, is well known for his work in collaboration with T. L. Brownyard on the distribution of water in set cement. Taking advantage of Mr. Powers's attendance at the Stockholm Conference on Winter Concreting, the Cement and Concrete Association asked him to give a lecture to an invited audience in London on March 1 at the Institution of Civil Engineers. More than seven hundred persons attended, covering a wide range of interests in civil engineering and concrete technology. It is a tribute to Mr. Powers's skill and enthusiasm that the highly specialized subject-matter of his talk was nevertheless received with absorption by his large audience, who were obviously stimulated by the many original observations.

Mr. Powers began by narrowing the field of discussion to the paste of cement and water which binds together the sand and larger aggregate. In his view, the major properties of concrete are largely determined by the paste alone, and the over-riding factor controlling the quality of the paste is the ratio of water to cement in the original mix. As hydration of the cement proceeds, some of the water becomes chemically combined, some is adsorbed in the gel resulting from the hydration, and some remains as free water in the capillaries present in the set mass. The properties of the gel, as quoted by Mr. Powers, are: density, 2·15 gm./c.c.; porosity, 26 per cent by volume; and coefficient of permeability to water, 2×10^{-15} cm./sec. The last is a remarkable figure for a substance of 26 per cent porosity, being less than is obtained with natural rocks of only 2–3 per cent porosity.

Mr. Powers then went on to elaborate a theory which caused a considerable controversy. It is well known, he said, that Portland cement is composed principally of tricalcium silicate, dicalcium silicate and various aluminates. Cements high in tricalcium silicate hydrate more rapidly and gain strength more quickly than others. This is usually explained by the fact that the aluminates react quickly with water, followed by the tricalcium silicate, while the dicalcium silicate hydrates react only slowly. Nevertheless, the evidence shows that in practical cement there is no preferential hydration of the different minerals. The evidence is threefold: constant specific surface of the gel from 1 day to 14 years; constant heat of reaction per unit of combined water from 1 day to 14 years; constant ratio of tricalcium to dicalcium silicate, as determined by the X-ray method, from the original cement up to 28 days. Mr. Powers did not offer an alternative theory to account for the differing reactivity of cements of different mineralogical composition.

The strength of the cement paste, on Mr. Powers's theory, is determined by how much of the capillary space is filled with gel. This gel/space ratio can be calculated from the original volumes of cement and water and the degree of hydration of the cement. A good relation was shown, graphically connecting the compressive strength of neat paste and the gel/space ratio. Mr. Powers then went on to use his theory to explain the variable coefficient of thermal expansion of concrete and to consider the bulk permeability and the frost resistance of concrete; especially in dealing with the latter property, it is necessary to allow for the accidental or deliberate entrainment of air during the mixing operation.

The discussion that followed the lecture mostly centred around the question of the differential hydration of cement minerals, and it is clear that this question will exercise the minds of cement technologists for some time to come. In replying to the vote of thanks, Mr. Powers made it clear that his work is not complete and that he had offered it for discussion in the hope that any errors or weaknesses might be repaired. R. W. Nurse

MOISTURE BALANCE OF THE ATMOSPHERE

FOR his presidential address to the Royal Meteorological Society, given on April 25, Dr. R. C. Sutcliffe chose for his subject "The Moisture Balance of the Atmosphere". With so much expression of opinion, both informed and uninformed, regarding the possible effects of nuclear explosions on weather and the possibility of artificially inducing precipitation from clouds, the subject was clearly a topical one; however, Dr. Sutcliffe, who is deputy-director of the Meteorological Office, had very little to say about the narrow 'rain-making' aspect and concentrated on presenting a broad picture of the various inter-related processes going on in the atmosphere, without an understanding of which attempts to tamper with the weather may lead to confusion and, possibly, disappointment.

After lamenting the tendency for new specialist branches of meteorology and applied meteorology to channel-off research energy from the main stream, which should be concerned with atmospheric processes as a whole and which has been very much neglected, Dr. Sutcliffe made the point that the circulation of water and water vapour in the atmosphere is but one aspect of the 'general circulation' of the air which carries it. The transport of water vapour is governed by the 'macro-dynamics'—that is to say, by the equations of fluid dynamics applicable to large-scale movements of air—though processes such as condensation and evaporation affect the application of mechanical principles by reason of alterations produced in the air-density. Precipitation, produced by the coalescence of cloud particles, also reacts back on

the motion since it affects future evaporation and condensation. If there were no coalescence of cloud particles, there would be clouds everywhere and the behaviour of the atmosphere might be expected to be different in many ways.

Dr. Sutcliffe classified the macro-dynamical processes, that is, processes on the scale of weather systems, as orographic, convective and cyclonic. Cyclonic developments occur mainly in middle latitudes, and he was curious to know why they have the size they are observed to have. It was unfortunate that he could not spare time to discuss theories which purport to explain this fact. In low latitudes a slow circulation of air in the planes of the meridians (the 'Hadley' circulation) evidently plays a large part in the transport of water vapour, as it does in the transport of heat and momentum; however, we also observe relatively small but intense disturbances called tropical cyclones. Dr. Sutcliffe wondered if a type of general circulation is possible in which the tropical cyclones play a part in low latitudes similar to that played by the extra-tropical cyclones (depressions) in middle latitudes. He claimed that, with the use of some imagination, one could see indications on climatic mean charts supporting this view.

A fact of some significance concerning the relation between rainfall and other processes going on in the atmosphere is the relatively small 'capital' of water vapour in the atmosphere as compared with the 'turnover'. Dr. Sutcliffe pointed out that there is, on the average, in the whole atmosphere, a total water content equivalent to only about ten days supply of rain. It follows that the total rate of rainfall must be rather closely controlled by the total rate of evaporation. Evaporation requires not only a supply of water but also a large supply of energy, and for control of weather over longer periods we have to look to those large reservoirs of both water and thermal energy, the oceans. The amount of energy required for evaporation is actually comparable with the infra-red radiation from the Earth's surface, and this led Dr. Sutcliffe to a discussion of the rather complicated energy-budget of the atmosphere. In drawing up a balance-sheet we have to use information derived in a variety of ways, some direct and some indirect, and little of it completely reliable. We are concerned not only with evaporation and precipitation and the convective transport of heat by air motions but also with radiative transfer in both the visible and infra-red regions. Various workers have attempted to draw up such a budget; but in many cases some entry has been made which is based more or less arbitrarily and uncritically on the work of others, and sometimes it is difficult to discover by whom and on what evidence a particular estimate was originally made. Dr. Sutcliffe paid special attention to some very recent calculations by Budyko of the energy balance of the atmosphere as a whole. Finally, he produced an estimate of evaporation and precipitation over land and over sea as a function of latitude. There appears to be only a very rough agreement between the estimates produced by different people at different times.

Appropriately, in view of the close inter-relation between different processes going on in the atmosphere, Dr. Sutcliffe ended by considering the relation between the local energy balance and weather systems. Energy supply to the atmosphere is deficient in anticyclones because less latent heat of condensation is released. It seems reasonable to suppose that they act as energy 'sinks', towards which energy is transported by air motion, and a more detailed analysis might indicate that their existence actually controls the development of new motions. It is not evident that the large anticyclones need always remain, even on average, in the same places, and Dr. Sutcliffe considered it possible that the atmosphere has more than one pattern of 'general circulation'. The idea is intriguing, and it is to be hoped that it will be followed up in the series of discussions on 'general circulation' problems, which, Dr. Sutcliffe announced, is being planned by the Royal Meteorological Society. One such discussion has already been held after the presentation to the Society of a brilliant theoretical paper by Dr. N. Phillips, of Princeton (see *Nature*, July 21, p. 129). Dr. Phillips has shown that very many observed features of the behaviour of the atmosphere are reproduced in the numerical integration of the equations governing a very simple model of the atmosphere. The prospects of transforming meteorology into an exact science are very much brighter now than they have ever been in the past.

E. T. EADY

UNIVERSITIES OF GREAT BRITAIN

1955 CONFERENCE

AT the 1955 Conference of the Universities of Great Britain and Northern Ireland, held during December 16–17, a number of topics were discussed, one of which, the age-group 'bulge' and its possible effect on university policy, has been reported in these columns (*Nature*, January 21, p. 115). The full report of the Conference proceedings, which has now been published*, summarizes the speeches and discussion at this session, and also those of the two preceding sessions on, respectively, the transition from the sixth form at school to the university and the financing of research in universities by outside bodies.

The first session was opened by speeches from Mr. H. D. P. Lee, headmaster of Winchester College, Miss K. Anderson, headmistress of the North London Collegiate School, and Prof. N. F. Mott, of Cambridge. Mr. Lee, starting from the findings of the report on university entrance requirements, claimed that we must not specialize at the expense of general education and that the latter includes, first, a certain minimum of academic achievement such as a certain standard in elementary mathematical operations, a certain ability to understand and write good English and some knowledge of a foreign language, as well as, secondly, at the level of the sixth form, an awareness of the place of specialized study in the field of human knowledge as a whole. He maintained that general education could not be provided at the university itself; it must be given in the schools. Miss Anderson outlined the problems of girls' schools more particularly, and referred to the growing tendency for consultation between the schools and the universities. She suggested that the schools could do more to develop individual responsibility for work. Prof. Mott stressed the importance of framing university entrance requirements and entrance scholarships to encourage the schools to provide time in the sixth forms, along with specialization, to

* Report of the Proceedings of the 1955 Conference of the Universities of Great Britain and Northern Ireland. Pp. 112. (London: Association of the Universities of the British Commonwealth, 1956.) 3*s*. 6*d*.

look at other fields of endeavour and see their relation to the main cause of study, and also the value of making it easy to change from the arts to the science side, or vice versa, later than the usual age of fourteen. In the discussion, Prof. J. L. Montrose, while welcoming much of Mr. Lee's address, dissented emphatically from the view that general education could only be given at school, suggesting that it comes late in a university career, even in postgraduate study, and in this he was supported by Dr. F. M. Brewer. Mr. S. R. Woods referred to the need for some method of assessing general education, and Dr. G. N. Burkhardt suggested that specialist study in the sixth form would be reduced if the syllabuses on which Advanced Level and Scholarship papers of the General Certificate of Education are set were reduced to two-thirds of their present size. This idea of pruning was supported by Mr. Lee and Miss Anderson; but Miss Anderson did not believe that general education could be examined.

Dr. V. E. Cosslett's paper on the financing of research in universities by outside bodies was read, in his absence through illness, by the chairman, Prof. J. L. Montrose. Basing his remarks on a recent investigation of the Association of University Teachers, Dr. Cosslett said that about 20 per cent of the research resources of university departments of science and technology are engaged on work of direct interest to industry and that about 5 per cent of university income is derived from industrial support for research. Grants from charitable foundations and learned societies provide a further 2 per cent, and research grants from government sources amount to about 7 per cent of university income. Dr. Cosslett raised the questions whether limits should be set to the amount of outside grants received by a university and to the proportion of sponsored research within this amount, and, if so, what principles should guide the universities in discriminating between grants. He suggested a limit of 50 per cent for outside grants and that not more than 50 per cent, preferably not more than 30–35 per cent, of research projects in a department should be sponsored projects.

Prof. H. W. Melville, who followed, dealt more particularly with the functions of the Department of Scientific and Industrial Research and the connexion between university scientists and government defence establishments; but he also commented on the relations with private industry, which is likely to become the largest contributor to the support of university research, and stressed the value of seconding industrial personnel to work in a university. Sir Harold Himsworth, who dealt largely with medical research, put the government contribution to university research at about £3 million, of which £1·17 million is from the Medical Research Council. He thought the device of establishing research units in association with universities has proved an elastic and effective way of dealing with special problems of common interest, but that there is a natural tendency for successful units to be taken over by university departments. Government support of research by non-academic bodies is, however, increasing and is likely to increase further. Sir William Slater was in general agreement with Sir Harold's remarks, as was Prof. A. R. J. P. Ubbelohde, who discounted some of Dr. Cosslett's statistics. Prof. N. F. Mott also did not share Dr. Cosslett's concern about support from industry, and Prof. J. A. Pope challenged the adequacy of the grants for postgraduate work by the Department of Scientific and Industrial Research.

NATIONAL FOUNDATION FOR SCIENTIFIC RESEARCH, BRUSSELS

REPORT FOR 1954–55

BESIDES the lists of recipients of grants for 1955–56 and the subjects of research, the eighteenth annual report of the National Foundation for Scientific Research, Brussels, covering the year 1954–55*, includes an inventory of microfilms and a list of publications by recipients of grants during the year under review. The Special Commission for Clinical Research received subsidies of 345,000 francs for the work at the University of Brussels on the effect of suprarenal-cortico hormones on the renal reabsorption of proteins, on the effect of suprarenal hormones on the metabolism of fructose in normal subjects, diabetics and patients suffering from hepatic deficiency, and on the inhibiting effect of plasmatic hypertony on the liberation of hormones of the suprarenal cortex provoked by a standard dose of adrenocorticotropic hormone; other work reported relates to the depressive action of cortisone on thyroid activity and to human suprarenalectomy. A grant of 350,000 francs for the State University of Ghent was for work on the influence of cortisone on the respiration of cardiac and diaphragmatic tissues, the stimulation of the suprarenal cortex by adrenocorticotropic hormone, the effects of the latter and cortisone on lipoproteins and the hydrolysis of corticoid urinary reducers. The State University of Liège received a subsidy of 520,000 francs for a comparative pharmacodynamic study of the effects on the organism of the injection of sodium salicylate and other compounds, and the Catholic University of Louvain 456,000 francs for its work on the hormonal inter-relations during gestation.

Grants to research workers for 1955–56 totalled 3,515,000 francs, while for the years 1956 and 1957 a total of 3,000,000 francs was allocated to the National Centre of Aeronautical Studies and Research. The first electronic calculating machine designed and constructed in Belgium was completed in Antwerp in February 1955. A special credit of 200,000 francs was made to enable M. Velghe to complete his astronomical work at the Boyden station of Harvard University at Bloemfontein in South Africa. Prof. M. de Hemptinne and M. Migeotte received a grant of 135,000 francs for their infra-red spectroscopical work, and Prof. J. Morelle, Ch. De Muylder and P. De Temmerman received 150,000 francs for their research on experimental coarctation and its retention and on vascular peripheral resistance.

Radioisotopes distributed in Belgium under the authority of the Foundation have been used in the following proportions: medicine, 31; industry, 25; agriculture, 6; physics, chemistry, biochemistry and applied sciences, 28; public services, 5. At the University of Brussels, the exchange of calcium between the bony tissues and the general organism has been studied in the dog with calcium-45; and the isotope phosphorus-32 has been used to study certain aspects of the dispersion of organic phosphorus compounds in the organism and their fixation on cholinesterase, the anti-cholinesterase activity in

* Fonds National de la Recherche Scientifique. Vingt-huitième Rapport Annuel, 1954–55. Pp. 269. (Bruxelles: Fonds National de la Recherche Scientifique, 1956.)

certain organo-phosphorus insecticides, including the synthesis of di*iso*propyl chlorophosphate and di*iso*propyl fluorophosphate, and the assimilation of carbon dioxide by micro-organisms by means of carbon-14 dioxide. At the University of Ghent the isotope zinc-65 has been used for establishing the distribution constants of zinc bromide in liquid–liquid extraction with diethyl ether and di*iso*propyl ether, carbon-14 has been used to study the influence of dinitro*cyclo*pentylphenol on the metabolism of alcohol in mice, and radioactive iodine has been used for studying the metabolism of iodine in infants suffering from lipoid nephrosis. At the University of Liège, carbon-14 has been utilized for preparing methyl iodide and L-methionine in studying the biological origin of the methyl group of adrenaline and of creatine; iodine-131 has been used for studying a number of toxic goitres, phosphorus-32 for studying the role of inhibitors of cholinesterase on the penetration of the phosphate ion in respiratory organs of the mussel, and carbon-14 for examining the metabolism of œstrone in the rabbit.

At the University of Louvain rubidium-86 has been used in studies of the beta–gamma angular correlation of this element, carbon-14 in studies of the decomposition of organic matter in the soil, and at the Royal Military School various studies, by means of chlorine-36 and iodine-131, have been made of heterogeneous reactions in the gaseous phase. At the State Agronomic Institute at Gembloux phosphorus-32 has been used in research on its eventual toxic effect on the development of the mycelium of mushrooms and in the chemical separation of phosphorus compounds such as phospholipoids, nucleoproteins, mineral compounds soluble in water and mineral compounds soluble in acids. In clinical work, gold-198 was utilized in three cases at the Centre for Tumours and Physical Medicine, iodine-131 in the treatment of thyrotoxicosis, while in industry iridium-192, cobalt-60 and cæsium-137 have been applied in the radiography of steel and in the detection of welding faults, and thallium-204 has been used in experiments on the elimination of static charges.

THE AFRICAN WILD DOG

THE African wild dog, or hunting dog, *Lycaon pictus*, is a distinct species and is neither related to any domestic breed nor does it appear to be the forerunner of any known type of domestic dog: there are certain structural differences, such as the absence of dew-claws. According to R. M. Bere, the dogs stand about twenty-six inches at the shoulder and measure about four feet from nose to tip of bushy tail (*Oryx*, **3**, No. 4; May 1956). The colour is variable, but is similar to that of a normal 'Alsatian' (German shepherd dog), the animal being covered to a greater or lesser degree with black, yellow or white blotches. A notable feature is the large upstanding, rounded ears. There are recorded cases of wild dogs having been successfully tamed; but an objectionable smell renders them somewhat unpleasant as household pets.

Wild dogs hunt in packs, killing wantonly far more than they need for food, and by methods of the utmost cruelty: *Lycaon* does not kill quickly as the lion does, but often starts to devour his antelope victim before life is extinct. They do more damage than almost any other of the Carnivorae; when they enter a particular stretch of country the disturbance they cause is so great that, for the time being, all the buck are driven out. The absence of antelope from an area is often the first sign of the wild dogs' presence. A particularly unpleasant characteristic is that they will, without hesitation, turn upon any member of the pack that falls by the way through wound or sickness and show no reluctance to consume their own kind.

When the Uganda National Parks were established it was considered necessary, as had been the case elsewhere, to shoot wild dogs in order to give the antelope opportunity to develop their optimum numbers. Fortunately, only a few wild dogs have had to be destroyed, and their number in the parks does not seem to be particularly large. Their habits do not allow them to stay for long in any one place, for they would starve if they did so: the wild dog packs create their havoc and move on.

The shooting of wild dogs has been questioned recently on the ground that, if persisted in, it would result in a disturbance of the balance of Nature. It was argued that should the antelope increase beyond a reasonable limit, the inevitable result would be starvation due to over-stocking and over-grazing. On balance it appears clear that, provided the packs do not increase beyond a reasonable size, they should not be interfered with. With wild animals generally, the rate of breeding and the percentage of those born to reach maturity is, in the absence of predators, largely controlled by the food supply. Generally speaking, the infant mortality among the Carnivorae seems relatively high, so that unless the food supply becomes abnormally easy, numbers just about maintain themselves.

THE SWEDISH FOREST SERVICE

THE forests of Sweden have played almost as important a part in Britain as in Sweden itself during the last half of the nineteenth century and the first half of the present, and it is not inappropriate, therefore, that the Swedish Forest Service should have published in English a handsome booklet on the development of the forests in relation to the Service*. It was the change in materials used for construction in Britain, especially for ships and buildings, which gave rise to a large demand for coniferous timbers, and Sweden seized the opportunity to exploit its large areas of coniferous virgin forests; until then the chief commercial home demand was for charcoal for the mineral industry. Swedish exports to Britain largely increased after the latter took off the import duty on softwoods in 1866. In fact, with its increasing industrial activity and increasing demands for pit wood for the coal mines, building timbers and paper pulp, Britain was lulled into a false sense of security; plans for starting afforestation in Britain, the subject of royal commissions, committees, etc., came to nothing, and by the end of the nineteenth century Sweden had built up a very prosperous export trade.

The early history of Swedish forests, though on a much larger scale, was similar to that of Britain to a great extent. In early times the king owned large areas, which were used for hunting purposes, and claimed all waste land. Then came a period in the

* The Swedish Forest Service. Pp. 44. (Stockholm: Swedish Forest Service, 1956.)

Middle Ages when the Church and the nobles owned much of the forests. At length, with the Reformation, Gustavus V confiscated all the Church property, and gradually it became the rule that all forests not in private ownership and used for the estates belonged to the State. When the foreign demand arose during the past century, the State again gave away large areas of forests to private people and timber merchants, and heavy unrestricted exploitation took place. A Forestry Institute had been founded in October 1828 by Israel Adolf von Strom, regarded as the 'father' of Swedish forestry, with the object of arousing interest in forestry throughout Sweden. The Institute became known later as the Swedish State College of Forestry, which held its centenary in 1928.

Sweden is divided for forestry purposes into three parts—northern, central and southern. The greater part of the State forests are in the north, where the soils are much poorer and, for climatic reasons as well, the growth is much slower. The Forest Service dates back to the seventeenth century, the duties then being to supervise royal hunting and to keep to the regulations as regards felling and selling forest produce by the people. In 1859 a Board of Forestry was established and six forestry schools were founded. Private forests were still outside any legislation. In 1883 the agricultural sections of State lands were placed under the Board of Forestry, and the name of the Board was changed to Board of Crown Lands and Forests. Under the Board came forests, the Forest Research Institute founded in 1902, and forest education, both higher and lower.

The most rapid progress was made in forest administration from the beginning of the century, one of the chief steps being the reorganization of the accounting system. Separate accounts officers were established in different parts of the country, and this allowed the forest officer, now relieved of much 'paper' work, to devote more time to his forests in the open, instead of chiefly in the office. The Forest Service had been a trading department, and this was changed by the formation of the Royal Swedish State Forestry Industries, Ltd., which is owned by the Forest Service; the supervision of private forests and public non-State forests was placed under a Royal Board of Private Forestry. The staff of the Forest Service is very much on the lines of that in Britain, as also is the forestry education. One difference is that a much greater latitude is given to the district forest officer, who is made responsible, within the administrative policy laid down, for all the work within his charge and has not constantly to refer to superior authority. E. P. Stebbing

THE ROSS GLACIER

By RICHARD BROWN

In view of the forthcoming work in the areas around the antarctic during the International Geophysical Year of 1957–58, it may be appropriate to review some observations on the Ross Glacier in South Georgia, Falkland Islands Dependencies, which date back to the first International Polar Year.

The island of South Georgia, some 120 by 25 miles (the long axis lying north-west–south-east), lies some 1,000 miles east of Cape Horn, between latitudes 54° and 55° S. It is entirely mountainous, the axial chain rising to almost 10,000 ft.

The Ross Glacier (lat. 54° 33′ S., long. 36° 05′ W.) is the chief feature of Royal Bay, a large inlet on the north-east coast of the island. It presents a wide front of ice cliff approximately 120 ft. high, calving into the water at the head of the bay, and rises to a low pass (the Ross Pass) which leads downwards by equally gentle slopes on the far side as the Brogger Glacier, to meet the sea on the south-west coast, where it calves into the waters of Undine South Harbour. The distance from coast to coast is almost 15 miles.

The German Transit of Venus Expedition had its base hut and observatory on the north side of Royal Bay during the years 1882–83. The party was a very hard-working one, for, in addition to the astronomical observations, work was also carried out in the fields of geology, zoology and botany. A survey of the area was made, and plots of the position of the ice front were made on four occasions: August 1882, December 1882, May 1883 and August 1883. There was recession between these dates, particularly the last two, amounting to a total of almost half a mile[1].

The next visitor to Royal Bay was Otto Nordenskjöld in 1902.

Before work in the Cumberland Bay area farther to the north, the surveyor of the Expedition, S. A. Duse, plotted the new position of the snout in April 1902. It was found that the ice-front stood in a position in advance of that of August 1882. The advance had been in excess of the total retreat noted by the German party. Nordenskjöld summarized his own and the German expedition's findings in his book "Antarctica"[2].

In December 1951 the area was visited by the South Georgia Survey, led by Duncan Carse. The true left bank of the glacier was used as a sledge route to the Ross Pass and the interior. The area was accurately mapped; but no glaciological work was undertaken[3]. In January 1955 the position of the snout was plotted by members of the British South Georgia Expedition, as part of the glaciological programme. This new position showed a large embayment near the south edge, and a considerable retreat of the north part of the snout. So far as comparison of the plans (on varying scales) permits, it would appear that the cliffs occupied a somewhat intermediate position between those of May and August 1883, and a considerable retreat from the 1902 position. On the south side of the glacier, recent moraines exist up to 600 ft. from the snout, and it may be that there was further advance after the 1902 maximum, for the 1882–83 and 1902 positions show little variation of the glacier's position on the shoreline, the main variation being in the position of the ice-cliffs in the water.

The glacier is derived from two main accumulation areas: that to the north from the peak ('Sunset Peak'; not an officially recognized name) at the south end of the Allardyce Range and the Ross Pass snowfields, and that to the south from the Salvesen Range, including a separate lobe which produces a large area of complex crevassing on the south side of the main stream of the glacier near the snout.

These two areas are of different altitude; that of the Allardyce is of a lower altitude than that of the Salvesen side by some 1,500 ft. on average.

In late January 1955 the summit of the Ross Pass (1,800 ft.) was surfaced with large irregular patches of firn, with intervening areas of bare hummocky ice. Ablation was proceeding (and continued elsewhere in the island at similar altitudes until March) and it

seems likely that in some seasons at least the firn line rises above the level of the pass. This means that in some years the net accumulation of the 'Allardyce part' of the glacier will be very small, confined to the slopes of 'Sunset Peak' above approx. 2,500 ft. The Salvesen accumulation areas, being generally much higher, will not come below the firn line, and any amelioration of climate will be less immediate in its effect on the volume of ice[4]. These areas are further fed from the surrounding cirque of peaks of more than 7,000 ft., from which large amounts of ice fall as avalanches.

It is interesting to note, in connexion with the 1902 position, that the greatest advance was in that part of the ice front associated with the Salvesen accumulation areas. The phenomenon of sudden considerable advance of a glacier is further exemplified by the recent advance of the Harker Glacier in Moraine Fjord, near the administration centre at King Edward Point in Cumberland Bay. There are two glaciers calving into the fjord; the Harker is the one at the head. Photographs taken during the Shackleton Expedition of 1914 compared with those taken up to 1952 show little difference in the position of the snout[5]. At some time after early 1952 there has been an advance of considerable dimensions and the snout has moved forward over flat ground at the head of the fjord for some 300 yards, as well as occupying a more advanced position in the fjord. The nearby Hamberg Glacier has remained quiescent. The position of both these snouts was plotted in December 1954, and their proximity to the settlement makes them very suitable for observations in the future.

South Georgia lies in the unstable area of the Scotia Arc. Whether these glacial surges are derived from ice avalanches of great magnitude caused by earth tremors is not certain, although a few earthquakes have been recorded in the island[6]. Further investigation of this factor might bring to light interesting data; but it would seem, at the present, that these surges occur only when the glacier is fed from some hanging ice-fall system, as is the case in both the Harker and the 'Salvesen accumulation area' part of the Ross Glacier. Prof. A. Desio has recently described the much larger (though apparently similar in character) advance of the 'Kutiàh Glacier' in the Karakorum Himalaya[7].

Thanks are due to the Governor of the Falkland Islands and to the Falkland Islands Dependencies Survey authorities for the opportunity to carry out this and other glaciological work in South Georgia.

[1] Will, Dr. H., and Mosthaff, E., *Deutsch. Geog. Blätter*, **7**, 113 (1884).
[2] Nordenskjöld, Otto "Antarctica", 345 (Hurst and Blackett, London, 1905).
[3] Carse, V. D., *Polar Rec.* **6**, 807 (1953).
[4] Ives, J., and King, C., *J. Glaciol.*, **2**, No. 18, 567 (1955).
[5] Hurley, "Shackleton's Argonauts", photo opp. p. 128 (Putnam, London, 1925). Shackleton, Sir E., "South", photo opp. p. 114 (1922). Chaplain, Lieut.-Comm. J. M., Discovery Rep., **3**, Plate XLIII, Fig. 1.
[6] Chaplain, Lieut.-Comm. J. M., Discovery Rep., **3**, 317.
[7] Desio, Prof. A., *J. Glaciol.*, **2**, No. 16, 383 (1954).

GROWTH AND SEXUAL MATURITY IN AQUATIC MAMMALS

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IN mammals growth is determinate, and there is an average adult size for individual species. The rate of growth is a specific phenomenon presumably fixed by heredity, and different species grow at different rates in the same circumstances and pass at different times through similar phases of development[1].

Owing to the practical difficulties there are few records of weights of aquatic mammals, and length is generally used as a measure of size. It is also a more accurate measure, being less subject to fluctuations than is weight. The average length of the female at puberty and physical maturity is known with some accuracy for the eleven cetaceans and twelve pinnipeds listed in Table 1, being based in most cases on a large number of specimens; but the length at puberty in the male is known with less accuracy. If we convert the length of the female at puberty to a percentage of the size attained when growth ceases it is seen to be remarkably constant, averaging in cetaceans 85·1 per cent (range 80·0–88·5, $\sigma = 3{\cdot}14$, $V = 3{\cdot}69$) and 86·6 per cent in pinnipeds (range 80·8–92·3, $\sigma = 4{\cdot}10$, $V = 4{\cdot}73$). This agreement is the more remarkable when it is observed that for several of the species considered the average lengths at these epochs in the life-cycle are known only approximately. The general shape of seals and whales shows marked resemblances, being fusiform with short appendages, and the length/weight relationship is probably similar in the two groups. This would help to explain the close similarity in the percentage length at puberty in these two unrelated groups; but clearly there is a fundamental and precise connexion between growth and sexual maturity.

We have little accurate information on the rates of growth of the various species of cetaceans, chiefly because no accurate method of determining age has yet been applied. Ageing by dentine layers in the teeth shows promise[11,12], and the use of incremental layers in the ear plug of the Mysticeti is being investigated[25].

In the teeth of Pinnipedia annual dentine layers[13] or external ridges[26] have been used with some success for determining the age of specimens, and mass-growth curves can be drawn up for several species (data from refs. 13, 14, 15, 18, 19, 21, 22, 26, 27). It can be shown that for this group the percentage increment in length during the first year may be used for comparative purposes as a measure of the rate of growth. When this increment is plotted against the average age at sexual maturity (Fig. 1) they are seen to be inversely proportional. In other words, the slower-growing species take longer to attain the level of about 86 per cent of the final length and so mature later than the precocious species. Since precocity in seals affects the embryonic growth-rate, the length at birth is also a reflexion of the rate of growth and bears a similar relationship to the age at puberty. A similar rule holds for the males, though maturity tends to be attained at a later age, and owing to the great variation in growth-rates (the polygynous species have a double sigmoid curve[12,22]) the percentage length at sexual maturity is not so constant. Likewise, in the species of whales for which we have

Table 1. Records of the Average Length of the Female on attaining Sexual Maturity and Physical Maturity

Species	Length in feet at		Length at sexual maturity as per cent of final length	Authorities (ref. No.)
	Sexual maturity	Physical maturity		
Cetacea				
Balaenoptera musculus	77	87	88·5	2, 3
B. physalus				
N. Atlantic	61·5	*c.* 70	87·8	4
Antarctic	65·5	74	88·5	2, 3
B. borealis	47·5	*c.* 54	87·9	5
B. acutorostrata	*c.* 24	*c.* 29	82·7	6
Megaptera novaeangliae	38·5	45	85·5	7
Berardius bairdii	33·5	< 40	> 83·7	8
Hyperoodon ampullatus	*c.* 21·2	*c.* 26	81·5	9
Physeter catodon	*c.* 30·5	*c.* 37	82·4	10
Globicephala melaena	*c.* 12	*c.* 15	80·0	11
Prodelphinus [*Stenella*] *caeruleo-albus*	7	*c.* 8	*c.* 87·5	12
Pinnipedia				
Mirounga leonina	97	115	84·3	13
Lobodon carcinophagus	87	95	91·5	14
Leptonychotes weddelli	90	100	90·0	14, 27
Hydrurga leptonyx	105	125	84·0	15
Erignathus barbatus	79	98	80·6	16, 17
Phoca groenlandica	60	65	92·3	18
P. hispida	43	50	86·0	19
P. vitulina	*c.* 56	64	87·5	20
Odobenus obesus	106	118	89·8	14, 21
Callorhinus ursinus	45	51	88·2	22
Arctocephalus pusillus	53	63	84·1	23
Otaria byronia	59	73	80·8	24

precise information, the male attains sexual maturity at a later age than the female. The sparse evidence available suggests that in general the faster-growing species of whales are those which mature early.

Whales and seals, being aquatic mammals, are able to bear young which are very much larger, both absolutely and relatively, than the young of the large terrestrial mammals. In the bear, for example, the weight of the new-born young in relation to the mother is 1 : 600, in the lion 1 : 160 [1], whereas in the elephant seal it is of the order of 1 : 30 and in the fin whale about 1 : 17. In the elephant this ratio is about 1 : 20 but the gestation period is greatly prolonged. During pregnancy, energy is required for fœtal growth and maternal growth, and reserves must be accumulated for the lactation period. To take an extreme example, the elephant seal pup weighs about 100 lb. at birth and gains about 350 lb. in the following three weeks, while the female probably loses about 700 lb.[13]. In the female it is therefore an advantage (speaking teleologically) to have completed or almost completed growth before bearing young, as otherwise the maternal and fœtal needs would compete for nutritional requirements.

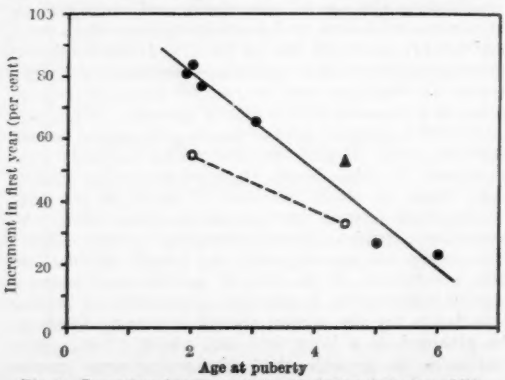

Fig. 1. Percentage increment in length during first year of life, related to age at puberty of the females of nine pinniped species: ●—●—, *Phocidae*; ▲—▲—, *Odobenus obesus* (walrus); ○—○—, *Otariidae*

If this relation between the rate of growth and the age of puberty proves to be a general rule, then it should be possible to predict the age at sexual maturity from the growth-rate, or vice versa. In the harbour seal (*P. vitulina*), for example, the length increment in the first year is about 30 per cent. This suggests that sexual maturity is attained at about 5–6 years of age instead of three years as usually given. It is more in line with the age at maturity of other members of the genus (*P. groenlandica* and *P. hispida*) and is also in closer agreement with recent population census figures for *P. vitulina*.

It would be interesting to examine the admittedly sparse data on growth-rates and relative lengths at puberty in other groups of mammals. It is possible that each group may have a specific relative size at maturity (determined perhaps by interactions between growth and gonadotrophic hormones of the anterior pituitary) of the same order as that shown to hold for whales and seals.

The nutritional level is probably the most important single variable affecting the shape of the growth curves, improved nutrition resulting in more rapid growth, especially in the younger stages. Improved nutritive conditions appear to lead to the precocious attainment of sexual maturity[29,30]. This could be a direct effect, since fertility is in general higher when food is readily available, or it might well be an indirect result of a higher level of nutrition stimulating bodily growth so that the size threshold for reproduction is reached at an earlier age.

I am indebted to Dr. F. H. Fay, Mr. A. W. Mansfield, Mr. I. A. McLaren and Dr. D. E. Sergeant for permission to use their unpublished data on pinniped growth-rates.

[1] Thompson, D'A., "On Growth and Form" (1952).
[2] Mackintosh, N. A., Discovery Reports, **22**, 197 (1942).
[3] Brinkmann, A., *Hvalradets Skr.*, No. 31 (1948).
[4] Jonsgård, Å., *Norwegian Whaling Gaz.*, **41** (2). 57 (1952).
[5] Matthews, L. H., Discovery Reports, **17**, 183 (1938).
[6] Jonsgård, Å., *Norwegian Whaling Gaz.*, **40** (5), 5 (1951).
[7] Chittleborough, R. G., *Austral. J. Mar. Freshw. Res.*, **6** (3), 315 (1955).
[8] Omura, H., Fujino, K., and Kimura, S., Sci. Rep. Whales Res. Inst., Tokyo, **10**, 89 (1955).
[9] Jonsgård, Å., and Oynes, P., *Fauna*, **1**, 1 (1952).
[10] Matthews, L. H., Discovery Reports, **17**, 93 (1938).
[11] Ann. Rep. Fish. Res. Bd. Canada (1954).
[12] Nishiwake, T., and Yagi, M., Sci. Rep. Whales Res. Inst., Tokyo, **8**, 133 (1953).
[13] Laws, R. M., Falkland Is. Dep. Survey Sci. Rep., No. 8 (1953).
[14] Bertram, G. C. L., British Grahamland Exp., Sci. Rep., **1** (1), 1 (1940).
[15] Laws, R. M., *Saugetierk. Mitt.* (in the press).
[16] Chapsky, K., and Kovolev, K., *Trans. Arctic Inst., Leningrad*, 123, 1 (1938).
[17] Naumov, S. P., "Seals of the U.S.S.R." (Moscow, 1933).
[18] Sergeant, D. E., unpublished data on *P. groenlandica* in letter (February 1956).
[19] McLaren, I. A., unpublished data on *P. hispida* in letter (December 1955).
[20] Havinga, B., *Tijdschr. Ned. Dierk. Vereen.*, Ser. 3, **3**, 89 (1933).
[21] Fay, F. H., unpublished progress report with data on rate of growth of *Odobenus obesus* (1954).
[22] Scheffer, V. B., and Wilke, F., *Growth*, **17** (3), 129 (1953).
[23] Rand, R. W., *Proc. Zool. Soc., Lond.*, **124** (4), 717 (1955).
[24] Hamilton, J. E., Discovery Reports, **19**, 121 (1939).
[25] Purves, P. E., Discovery Reports, **27**, 293 (1955).
[26] Rand, R. W., Union S. Africa, Govt. Guano Is. Admin. Progress Rep. (1949).
[27] Mansfield, A. W., Falkland Is. Dep. Survey Sci. Rep. (in the press).
[28] Scheffer, V. B., *Science*, **112**, 309 (1950).
[29] Morton, G. H., and Cheatum, E. L., *J. Wildlife Mgt.*, **10**, 242 (1946).
[30] Cheatum, E. L., and Severinghaus, C. W., Trans. N. Amer. Wildlife Conf., **15**, 170 (1950).

POLYPLOIDY IN BLUEBELLS (*ENDYMION NON-SCRIPTUS* AND *E. HISPANICUS*)

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WITH the exception of occasional variations in heteroploid varieties of *Endymion non-scriptus* (*Scilla non-scripta*) mentioned by Darlington[1], all previous cytological studies[2-4] on this and the closely related species *E. hispanicus* (*S. hispanica*) have revealed only the diploid plant, and no record seems to have been made in the literature about polyploidy in this genus as found in the allied one, *Hyacinthus*[5].

During cyto-genetical studies on the English bluebell, *E. non-scriptus*, in three Cambridgeshire woods a number of odd 'giant' forms was noticed. When these were examined cytologically in both root-tip mitosis and pollen mother-cell meiosis, some of them were found to be still merely diploid, while others were triploid ($3n = 24$) (Fig. 1*A*). None of them has been found to be tetraploid.

In the Spanish bluebell, *E. hispanicus*, some huge forms were found in gardens, and these on similar examination proved also to be triploid ($3n = 24$) (Fig. 1*B*).

The two species have essentially the same complement of chromosomes ($2n = 16$), and attempts have been made by Sato[3] and Margherita and Maugini[4] to compare them. The former author reported that the only difference was that the satellite attached to chromosome *D* in *E. non-scriptus* was lacking in the corresponding chromosome in *E. hispanicus*; the latter authors, apart from what must be a confusion between chromosomes *B* and *C*, noticed that only one of the *D* chromosomes in *E. hispanicus* carried a satellite. My own observations show that the satellite could show all degrees of contraction and may even be torn off, so that a distinction between the chromosomes of the two species is not always possible with reference to this structure.

This great similarity in chromosome complement would be expected to facilitate hybridization between the two species; but strangely enough what has recently been given as 'hybrids' by de Mol van Ould Loosdrecht[6] and Turrill[7] are extraordinarily large forms. The former described a 'giant scilla' which he claimed to be a cross-bred form, while the latter has given a drawing of what he considers a hybrid that arises in gardens when the two species are together; he does not describe it, but from his drawing this 'hybrid', like that of the former author, is apparently also a 'giant', being about twice the size of the normal parental forms. These rather robust forms, apart from their huge size, really show characters that appear intermediate between the two species. Cytological examination has shown them also to be triploid ($3n = 24$) (Figs. 2 and 3*A* and *B*).

But, owing to the difficulty stated above, the possible hybrid origin of this triploid form could not be readily determined from chromosome morphology. Other cytological examinations like pairing at meiosis (Fig. 3*A*) do not

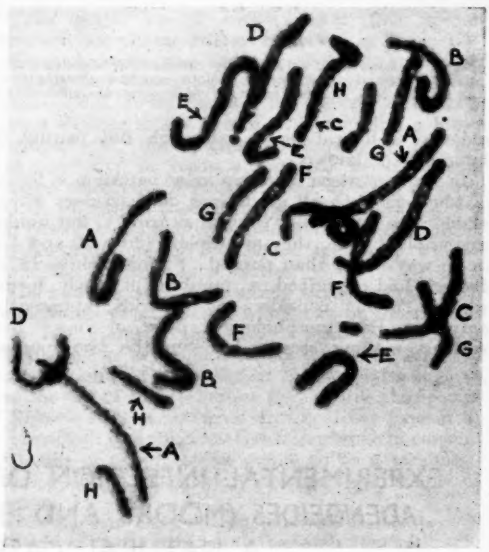

Fig. 2. Chromosomes of triploid ($3n = 24$) with characters intermediate between *E. non-scriptus* and *E. hispanicus*. Metaphase chromosomes of root-tip mitosis (× 1,500). The arrows indicate roughly the position of the centromeres, which are not shown owing to difficulty in focusing

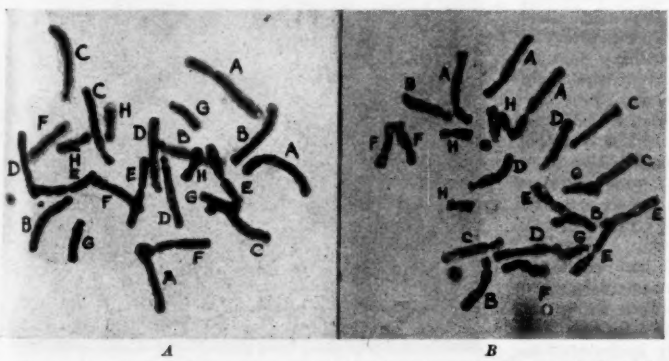

Fig. 1. *A*, metaphase chromosomes of root-tip mitosis (treated with oxyquinoline) of triploid ($3n = 24$) *Endymion non-scriptus* (× *c.* 1090); *B*, metaphase chromosomes of root-tip mitosis (treated with oxyquinoline) of triploid ($3n = 24$) *E. hispanicus* (× *c.* 1090)

A *B*

Fig. 3. *A*, same as Fig. 2. Metaphase chromosomes of pollen mother-cell meiosis showing eight trivalents (× *c.* 900); *B*, meiotic anaphase showing twenty-four chromosomes (× *c.* 540). N.B. In Figs. 1 and 2 the chromosomes are numbered according to Darlington[1]

indicate a hybrid origin, although full pairing in hybrids is unknown[5].

In many gardens there is a great variation in forms of bluebells with all gradations of characters which make them appear like 'hybrid swarms'; but unlike this triploid form, they are diploid ($2n = 16$) and are in no way larger than normal. So far back as 1872, Baker[6] had described a number of such forms which Turrill[7] considers as hybrids apparently only from the morphological point of view; but without making crosses between the two species, one would require adequate cytological and other examinations to verify the hybrid origin of any of them.

It may be mentioned here that one of these diploid intermediate forms, often found in no small quantity in gardens, agrees rather well with what Baker described and assigned to *Scilla patula*; except for size this also compares favourably with this triploid form in question. Thus in view of the apparent absence of any cytological and other evidence to justify the hybridity of this, it may well be that Turrill's 'giant' hybrid is a non-hybrid triploid of this variety of bluebell.

I am indebted to Dr. H. L. K. Whitehouse for placing his garden of *E. hispanicus* at my disposal for this work.

[1] Darlington, C. D., *J. Genet.*, **16**, 237 (1926).
[2] Sato, D., *Bot. Mag. Tokyo*, **49**, 297 (1935).
[3] Elliott, C. G., Ph.D. thesis, Cambridge (1953).
[4] Margherita, M. E., and Maugini, E., *Caryologia*, **4**, No. 3, 359 (1952).
[5] Darlington, C. D., "Recent Advances in Cytology" (Churchill, 1937).
[6] de Mol van Ould Loosdrecht, W. E., *Gard. Chron.*, **128**, 219 (1950).
[7] Turrill, W. E., *Curtis's Bot. Mag.*, N.S., **176** (1952).
[8] Baker, J. G., *Gard. Chron.*, 1038 (1872).

EXPERIMENTAL INFECTION OF TURKEY POULTS WITH *EIMERIA ADENOEIDES* (MOORE AND BROWN, 1951) ISOLATED FROM A NATURAL CASE IN GREAT BRITAIN

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SEVEN species of *Eimeria* have been identified in turkeys in the United States[1]. The oocysts of three species (*E. meleagridis*, *E. gallopavonis* and *E. adenoeides*) are so similar that they cannot be distinguished from one another in the fæces of infected birds[2]. All three are localized in the terminal small intestine, cæcum and rectum, and mixed infections cannot therefore be separated into species by their distribution in the host. *E. adenoeides* is believed to be the most pathogenic, its distinguishing feature being that it undergoes development in the deep glands of the mucosa and not only in the villi.

Coccidiosis is common in turkey poults in Great Britain[3] and is believed to be due to *E. adenoeides*[4]; but this species has not to our knowledge been identified with certainty or studied as a pure infection in Great Britain. This communication reports the preliminary findings with a pure strain of *E. adenoeides* derived from a single oocyst.

Oocysts were obtained from clinical cases of coccidiosis in poults where oocyst measurements and microscopic lesions suggested *E. adenoeides* infection.

From a sample of intestinal contents from one such poult, three single oocysts, previously sporulated in 2·5 per cent potassium bichromate, were transferred by the use of a simple micromanipulator[5] to pieces of 'Cellophane' about 1 cm. square. After examination

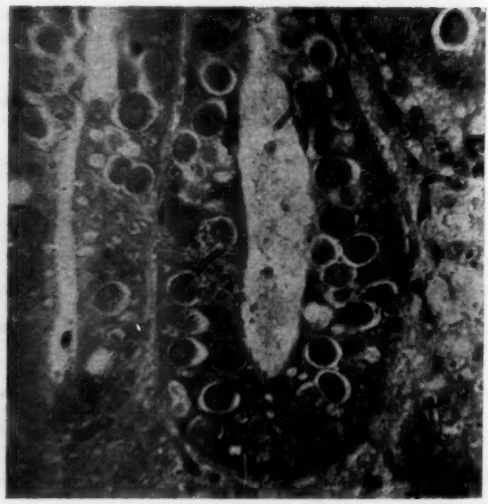

Fig. 1. Lower ileum of three-week old turkey poult killed six days after infection with 30,000 oocysts. Massive invasion of epithelial cells of deep glands by sexual stages of *E. adenoeides*. (Heidenhain's iron hæmatoxylin, × 470)

Table 1

	Site of infection	Measurements (μ)	Sporulation time (hr.)	Prepatent period (hr.)	Refractile body	Pathogenicity
E. adenoeides Moore and Brown, 1951	Lower ileum, cæca and rectum Deep glands as well as villi	Length 18·95–31·26 Width 12·60–20·94 Average 25·60 × 16·59 Ratio length : width 1·54 : 1	24	112 (approx.)	Present	++
Strain *A*	Lower ileum, cæca and rectum Deep glands as well as villi (Fig. 1)	(150 oocysts) Average length 25·68 Standard deviation 1·81 Average width 16·25 Standard deviation 1·21 Ratio length : width 1·58 : 1	24	120 (approx.)	Present	+

under the microscope, each was transferred to a gelatine capsule, and inserted into the crop of a fourteen-day old turkey poult which had failed to show oocysts in its fæces by a sugar flotation technique when examined daily since hatching. This procedure was repeated with three single oocysts from a natural case of coccidiosis in another flock. To prevent extraneous infection, the most stringent precautions were taken, such as heat sterilization of apparatus, utensils and cages, the use of a small isolation room which was disinfected with gaseous ammonia, and the changing of clothing and boots on entering this room. Six control birds of the same hatch, in the same room and given the same food and water, failed to show oocysts in the fæces, which suggests that the precautions taken were adequate.

Two birds, one from each group of three, became infected, oocysts being first detected in the fæces on the sixth day. Fæces were collected separately for the next 72 hr., and the oocysts sporulated. The material from one contained a total of some 150,000 oocysts (strain *A*), of which 95 per cent sporulated after 24 hr. in 2·5 per cent bichromate at 26° C. This material has been used for further work; material from the other infected bird will be studied later to see whether it is the same species as strain *A*.

Each of five coccidia-free poults, given 10,000–30,000 oocysts of strain *A*, showed oocysts in the fæces five days later. Further experiments with the large stock of sporulated oocysts derived from the original single oocyst showed that this species possessed the characteristics indicated in Table 1.

These characteristics agree closely with those given by Moore and Brown[1], and identify the coccidium as *E. adenoeides*. It will be seen that the only differences were a slightly longer prepatent period and a lower pathogenicity. Moore and Brown refer to 100 per cent mortality in birds up to five weeks of age, whereas using only a small number of birds we have had no mortality, though the poults refused all food and passed blood and cæcal plugs in their droppings. Further confirmatory tests as to specificity will be made later by immunity studies.

The relative ease of obtaining single oocysts with a simple micromanipulator which can be constructed in a few minutes, the success that followed the administration of single oocysts to poults, and the identification of the species as *E. adenoeides* suggest that the use of this technique may enable the species of *Eimeria* that occur in turkeys in Great Britain to be identified, and their relative importance in causing outbreaks of coccidiosis in poults to be determined. A study of the life-cycle of *E. adenoeides* is now in progress.

This work is being conducted with the help of a grant from the Agricultural Research Council.

[1] Moore, E. N., Brown, J. A., and Carter, R. D., *Poultry Sci.*, **33**, 925 (1954).
[2] Moore, E. N., and Brown, J. A., *Cornell Vet.*, **41**, 125 (1951).
[3] Ford, E. J. H., *Brit. Vet. J.*, **112**, 3 (1956).
[4] Horton-Smith, C., personal communication.
[5] Goldacre, R. J., *Nature*, **173**, 45 (1954).

FLOW OF GASES THROUGH PACKED BED OF SILICA POWDER AT LOW PRESSURES

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THE relationship between the permeability of a packed bed and the pressure of the flowing gas is linear at low flow-rates of gas. It has been observed that in the case of flow through capillaries at low pressures, say, smaller than 1 mm. mercury, the gas flow-rate assumes a minimum value and then rises to a limiting value at zero pressure (Knudsen, Gaede and Smoluchowski), which was found to be higher than the value expected from the slope of the line.

In the low-pressure region, where the mean free path is larger than the average diameter of the capillary, both the molecular and surface diffusion flows are responsible for the existence of the minimum in the flow-rate. The absence of such a minimum in the case of flow through powders was said to be characteristic[1], the reason being that all types of flow, molecular and surface diffusion, can occur simultaneously in pores of various diameter and thus obscure the individual types of flow[2].

The change of slope has been found to occur at pressures where the length of the mean free path approached the diameter of the voids[3].

In our work, permeation through a bed of fine silica powder at the lower range of pressures, particularly 0–10 microns mercury, was studied, at low flow-rates and ambient temperature. When considering the resistance to flow offered by a powder it is convenient to use the term specific conductance K which, in effect, is the conductance of 1 c.c. of the powder

$$K = \frac{CL}{At} \quad (\text{cm.}^2/\text{sec.})$$

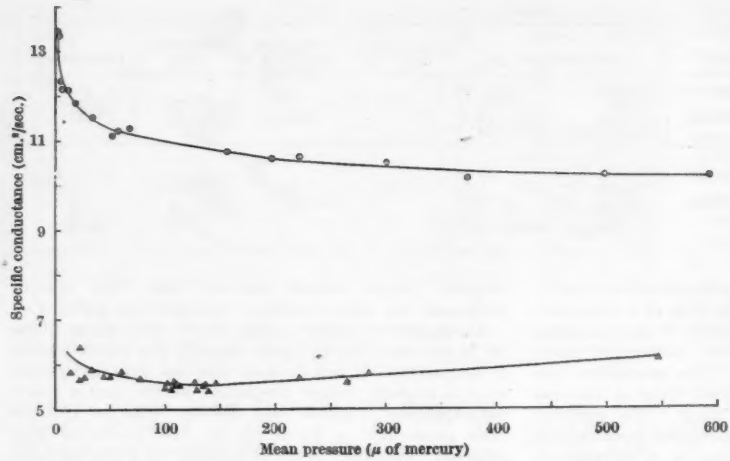

Fig. 1. ⊙—⊙—, Air (carbon dioxide-free); △—△—, 'Freon' (commercial purity)

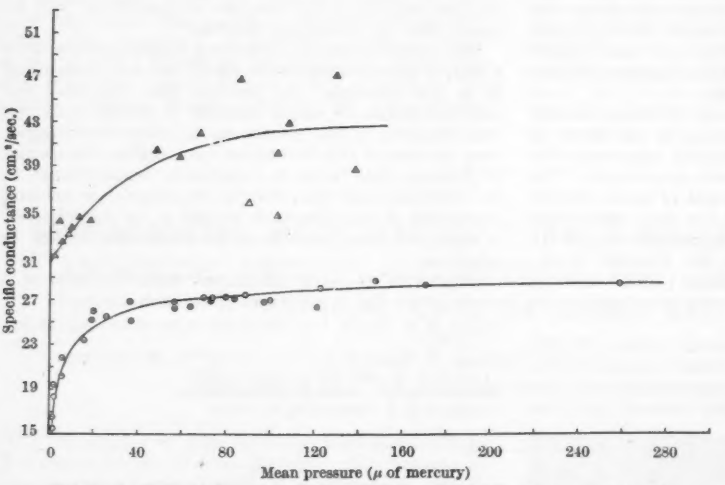

Fig. 2. △—△—, Hydrogen (oxygen-free); ⊙—⊙—, helium (spectroscopic purity)

where C is flow-rate/pressure drop; L is bed-length; A is bed cross-section area; t is time.

The specific conductance investigated in this work varied from 5 to 50 cm.³/sec. Four gases were investigated, namely, hydrogen, helium, air and difluorodichloromethane ('Freon') vapour, in order to cover a wide range of densities. The purity of hydrogen was 99·95 per cent; helium was spectroscopically pure, the total amount of impurities being not more than 8 p.p.m.; air was free of carbon dioxide and dry, the amount of water being less than 1 p.p.m., and 'Freon' was of commercial purity 99·99 per cent CF_2Cl_2.

The silica powder used in our experiments had a grain size of the order of 4×10^{-6} cm. and specific surface area of 100 sq. m. per gm., thus falling in the category of adsorbents. Pressure-drop was measured with a precise differential manometer described elsewhere[4] and gas-flow by a flow meter developed specially for the very low flow-rates.

The results presented in Figs. 1 and 2 show that the relationship between the specific conductance and gas pressure maintains its linearity to a certain low value of pressure, below which further trends are not uniform by any means. The two heavier gases, 'Freon' and air, show increase in specific conductance at zero pressure, while the lighter ones, helium and hydrogen, show the opposite. It is thus apparent that there is present a new mechanism of flow which, so far as the experimental evidence has shown, is related only to molecular weight of the gas and not to its mean free path.

It is expected that surface adsorption plays a part in the transport of molecules across the silica bed. The mobility of molecules adsorbed on a solid surface is now generally recognized[5] as against rigid concentration of sorbate on fixed sites which amounts to chemisorption. Surface diffusion is responsible for the free thermal motion of molecules adsorbed on the solid surface.

This should be distinguished from 'interstitial diffusion' encountered when a gas is sorbed by a medium, the pore diameters of which are comparable with the sizes of the molecules, for example, dehydrated zeolites[6]. It is thus not possible to speak with certainty of 'adsorption' or of 'internal surface' when the state of the molecules is more akin to solid solution than to pure adsorption. The kinetics of interstitial adsorption are governed primarily by the variations of molecular size, and in some cases it is possible to arrange molecular sieves which would allow for permeation of molecules below certain sizes.

In contrast to both Knudsen and interstitial diffusion, surface diffusion tends to be more marked in the case of larger and heavier molecules. Gas flow through micropores takes place by molecular streaming through the gas space. When using a very fine powder and condensable gases or vapours, surface flow is also expected to take place. As a result of it, the rate of flow is enhanced, that is, surface flow takes place in parallel with the flow in the gaseous phase.

[1] Carman, P. C., and Malherbe, P. le R., *Proc. Roy. Soc.*, A, **203**, 165 (1950).
[3] Carman, P. C., *Proc. Roy. Soc.*, A, **203**, 55 (1950).
[2] Wicke, E., and Vollmer, W., *Chem. Eng. Sci.*, **1**, 282 (1952).
[4] Gaffee, D. I., and Monroe, A. G., *Nature*, **174**, 756 (1954).
[5] Bangham, D. H., and Fakhoury, W., *Proc. Roy. Soc.*, A, **130**, 81 (1930).
[6] Barrer, R. M., and Ibbitsen, D. A., *Trans. Farad. Soc.*, **40**, 195, 206 (1944).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Hexafluorobenzene

THE application of gas–liquid partition chromatography to organic fluorine chemistry[1,2] has enabled us to extend our studies on dehydrofluorination to a nonafluoro*cyclo*hexane (I) (b.p. 92°) which has been obtained[3,4] by passage of benzene vapour over cobaltic fluoride at about 150°. With concentrated aqueous potassium hydroxide, this polyfluoride (I) gave a complex mixture (b.p. 60–90°) which was shown by analytical gas-chromatography to contain nine individual components. These were separated by use of the preparative-scale gas chromatographic column, and the structures of some of them have been determined by spectroscopic examination, oxidative degradation, addition reactions, etc.

(I)

(II) X=H, Y=F
(III) X=F, Y=H

(IV)

(V)

(VI)

Two heptafluoro*cyclo*hexa-1 : 3-dienes (II) (III), a heptafluoro*cyclo*hexa-1 : 4-diene (IV), and an octafluoro*cyclo*hexene (V) were thereby identified. Also, as one of the major products, the important fluorocarbon hexafluorobenzene (VI) was isolated and characterized. The great value of the gas-chromatographic technique in effecting the separations, on a relatively small scale, of complex mixtures such as this is readily apparent. Hexafluorobenzene was prepared in amounts sufficient to carry out a preliminary study, and we have shown that chlorine will add to the ring system to give hexachlorohexafluoro*cyclo*hexane, and that attack by nucleophilic reagents is relatively easy. Thus, with methanolic sodium methoxide, pentafluoroanisole and a tetrafluorodimethoxybenzene were given. These reactions are being actively pursued at present, for a wide field of investigation has been opened up.

The nonafluoro*cyclo*hexane precursor is shown by the products II–VI to be a 1H : 2H : 4H-compound (I). The isolation of hexafluorobenzene upon dehydrofluorination suggests that the hydrogens on carbons 1 and 2 are both axial. Since *trans*-elimination of hydrogen fluoride between these two CHF groups cannot then occur, the more difficult 'outwards' elimination, with fluorine being lost from the —CF_2— groups, can operate. Similar conclusions apply to the 1H : 2H-decafluoro*cyclo*hexanes, where the *cis*-compound gives exclusively 1H-nonafluoro*cyclo*hexene on dehydrofluorination[5], but the *trans* gives, besides this, some octafluoro*cyclo*hexa-1 : 3-diene[6].

Hexafluorobenzene has been reported before. McBee, Lindgren and Ligett[6] made it from hexachlorobenzene; their product was probably slightly impure and no reactions were given. Désirant[7] claimed to have obtained it by pyrolysis of tribromofluoromethane; but no experimental details were reported.

Experimental. 1H : 2H : 4H-*Nonafluorocyclohexane.* Benzene was passed in the vapour phase over cobaltic fluoride in a stirred reaction vessel at 150°. The reactor and the conditions described earlier[3] have been improved[4] to give increased yields of polyfluorides with no benzene remaining. Further fractionation, controlled by gas-phase chromatography, of the material having b.p. > 87° gave 1H : 2H : 4H-*nonafluorocyclohexane*, b.p. 92·0–92·5°, m.p. 44–46°, n^{45} 1·3016 (found: C, 29·2; H, 1·2. $C_6H_3F_9$ requires C, 29·3; H, ⅄ 2 per cent). Yields were 10–15 per cent of the original polyfluoride mixture.

Hexafluorobenzene. The trihydro-compound (50 gm.), potassium hydroxide (85 gm.) and water (250 c.c.) were refluxed together until analytical gas-chromatographic examination showed a large peak due to the desired compound (17 hr.). The organic layer was separated, dried (magnesium sulphate), distilled, and subjected to gas-chromatographic separation. The hexafluorobenzene (5·0 gm.) had b.p. 80°, n_D^{25} 1·3746 (found: C, 38·6; F, 62·0. Calc. for C_6F_6: C, 38·7; F, 61·3 per cent). McBee *et al.*[6] gave b.p. 81–82°, n_D^{25} 1·3760, and Désirant[7] b.p. 80·5°, n_D^{20} 1·3777. Infra-red spectroscopic measurements (on the pure liquid) showed three bands at 1,702, 1,761 and 1,802 cm.$^{-1}$. A band was found in the ultra-violet at λ 2300 A., ε approx. 770 with an inflexion at λ 2500–2550 A. (*c*, 0·11 gm./l. in ethyl alcohol).

Reactions of hexafluorobenzene. (*a*) *Chlorine addition.* Chlorine (1·2 gm.) and the compound (1·0 gm.) were sealed together in a hard glass tube which was irradiated with ultra-violet light for 48 hr. The product was washed (aqueous sodium metabisulphite), dried (P_2O_5) and distilled to give *hexachlorohexafluorocyclohexane* (1·24 gm.), b.p. 137°/30 mm., m.p. 101–102° (found: F, 28·8. $C_6Cl_6F_6$ requires F, 28·6 per cent). This compound showed no absorption in the infra-red due to unsaturation over the range 1,890–1,580 cm.$^{-1}$.

(*b*) *Action of sodium methoxide.* Hexafluorobenzene (4·8 gm.) was refluxed with methanolic sodium methoxide (40 c.c.; 1 *N*) for 1 hr. The mixture was poured into water and the product extracted with ether. The extracts were washed, dried (magnesium sulphate), and evaporated and the residue distilled to give two fractions: (i) b.p. 145–160° (2·9 gm.) and (ii) b.p. 160–180° (0·7 gm.). Fraction (i) was redistilled to give *pentafluoroanisole*, b.p. 155–157°, n_D^{25} 1·417 (found: C, 42·5; H, 1·8. $C_7H_3F_5O$ requires C, 42·4; H, 1·5 per cent). Fraction (ii) on being kept deposited crystals which were recrystallized from aqueous ethanol to give a *tetrafluorodimethoxybenzene* (0·15 gm.), m.p. 51·5–52·5° (found: C, 46·0;

H, 3·1. $C_8H_8O_2F_4$ requires C, 45·7; H, 2·9 per cent).

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[1] Evans, D. E. M., and Tatlow, J. C., *J. Chem. Soc.*, 1184 (1955).
[2] Evans, D. E. M., and Tatlow, J. C., Symposium on Vapour Phase Chromatography (Hydrocarbon Research Group, Institute of Petroleum), May–June 1956, Preprints of papers, p. S198.
[3] Barbour, A. K., Mackenzie, H. D., Stacey, M., and Tatlow, J. C., *J. App. Chem.*, **4**, 347 (1954).
[4] Smith, R. P., and Tatlow, J. C. (forthcoming publication).
[5] Roylance, J., Tatlow, J. C., and Worthington, R. E., *J. Chem. Soc.*, 4426 (1954).
[6] McBee, E. T., Lindgren, V. V., and Ligett, W. B., *Indust. Eng. Chem.*, **39**, 378 (1947).
[7] Désirant, Y., *Bull. Classe. Sci. Acad. Roy. Belg.*, **41**, 759 (1955).

Organophilic Montmorillonite Gels

Infra-red absorbance measurements on hydrocarbon gels of dimethyl dioctadecyl ammonium montmorillonite[1] indicate that polymeric-type hydrogen bonding is significant in systems containing this clay mineral derivative. For example, Fig. 1 shows free hydroxyl and bonded hydroxyl absorbances in the 3-micron region for a 20 per cent dispersion of dimethyl dioctadecyl ammonium montmorillonite in a mixture containing 75 per cent cumene and 25 per cent cetane.

We suggest as one possible gelation mechanism that water, present in small amounts in the organophilic clay, forms bridges which hold montmorillonite platelets together, causing a network that leads to gel formation. This explanation appears to account for the unusual properties of these systems. Thus, they are affected by dehydration and, after standing in a desiccator, they are converted by working from gels to viscous liquids. If they are then put into another container over water, they recover their gel status as water vapour is absorbed. These gels lose consistency, as working causes montmorillonite platelets to approach parallel positions. This is apparently because bridging through the solvated layer of organic material is more difficult in the tactoid arrangement which results from working.

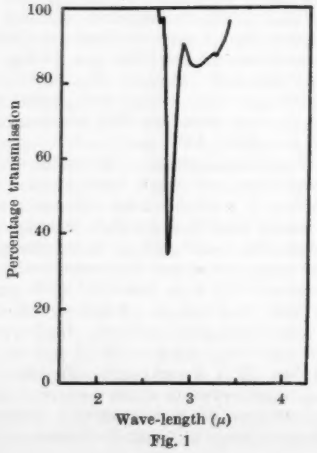

Fig. 1

But the turbulence which accompanies treatment in a sonic generator, colloid mill, paint mill or homogenizer causes platelet edges to force through the solvated layer of other platelets and make bonding contact with the underlying silicate portion of these, thus stiffening the network and explaining the increase in consistency which accompanies such treatment. At high temperatures (>150° C.), a rather firm network can form, apparently because thermal turbulence and loss of solvation in the organic layer permit a closer approach of the inorganic core of particles. This explains the unusual effect observed, that a system in the viscous liquid state changes to a gel when heated. Less water is required for network formation at these higher temperatures, and possibly no water at all, since the approach of the inorganic parts of different platelets may be so close that attractive forces between aluminium ions at the edges of the octahedral layers and negative spots on the faces of other platelets may be large enough to account for network formation.

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[1] Damerell, V. R., *Indust. and Eng. Chem.*, **48**, 321 (1956).

An Ambiguity in the Variable-Solvent Solubility Test: Homogeneity of β_1-Lactoglobulin

In the variable-solvent solubility test (see, for example, Falconer and Taylor[1], Derrien[2], Smithies[3]) a constant amount of protein is brought to a series of different concentrations of a salt, the volume, *p*H and temperature being constant. The equilibrium concentration of protein remaining in solution is then plotted against the concentration of salt. A single protein is expected to give a curve like that in Fig. 1. Here *AB* represents the exponential solubility relationship of the protein[4]. Under conditions represented by the horizontal part *PQ* of the curve (the position of which depends on the amount of protein and

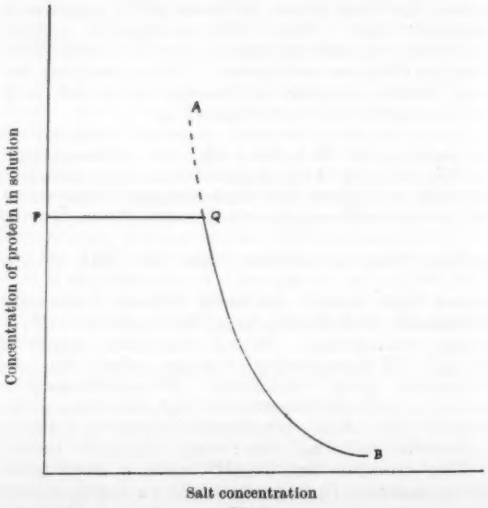

Fig. 1

the volume chosen) all the protein remains in solution; solid phase first appears at Q where PQ cuts AB, and from this point the curve follows AB as the concentration of salt is increased.

The occurrence of more than one discontinuity is normally interpreted as showing the presence of more than one protein in solution. The case of two proteins, which do not interact in solution or in the solid phase, is illustrated in Fig. 2. Each protein has its own solubility curve A_1B_1 and A_2B_2. A_sB_s, the sum of A_1B_1 and A_2B_2, is the combined solubility curve when both solid phases are present. If, for example, the proportions of proteins 1 and 2 in a mixture are as 1 : 2 (P_1, P_2 total concentration P_s), then each protein is independently salted out along $P_1Q_1B_1$ and $P_2Q_2B_2$. The combined curve is the sum of these, namely, $P_sQ_sR_sB_s$, Q_s corresponding to Q_1 and R_s to Q_2. If the amount of protein P_s is changed to P'_s or P''_s, leaving the proportions of 1 and 2 unchanged, curves $P'_sQ'_sR'_sB_s$, $P''_sQ''_sR''_sB_s$ are obtained. Two important characteristics of these curves should be noticed: (i) if Q_1 and Q_2 should happen to have the same abscissa value, then Q_s and R_s coincide; but it is very unlikely that this will happen for all values of P_s; (ii) the position of R_s on A_sB_s changes as P_s is changed.

The occurrence of more than one discontinuity in the salting-out curve may, however, result from a quite different situation, namely, when a single protein in solution is in equilibrium with different solid phases, according to the concentration of salt.

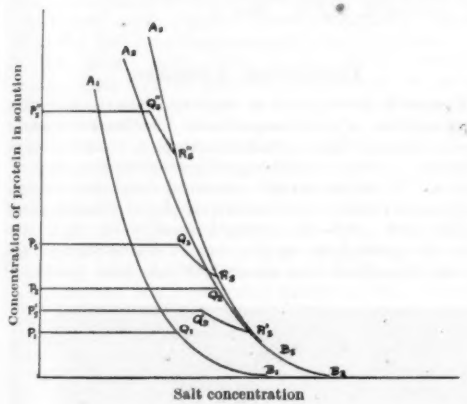

Fig. 2

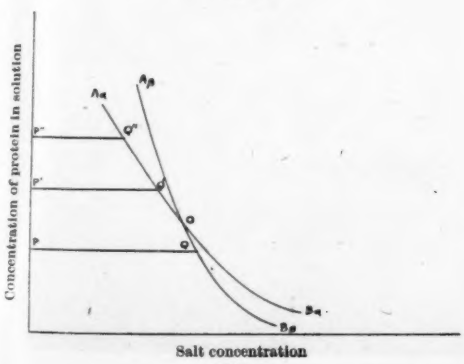

Fig. 3

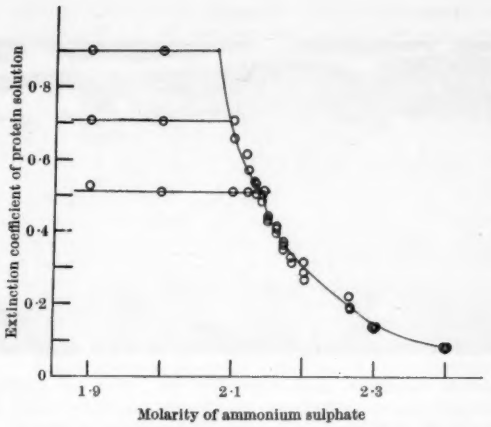

Fig. 4. β_1-lactoglobulin, pH 5·0, 25° C., 0·2 M sodium chloride, 0·2 M acetate–acetic acid buffer

Fig. 3 illustrates this case for two solid phases α and β which have solubility curves $A_\alpha B_\alpha$ and $A_\beta B_\beta$. To the right of the transition point O, β is the stable solid phase; to the left of O, α is stable. If the amount of protein is chosen so that PQ cuts $A_\alpha OB_\beta$ below O, there is only a single discontinuity q; but at higher values of P, curves $P'Q'OB_\beta$, $P''Q''OB_\beta$ are obtained, each having two discontinuities at Q' or Q'' and at O.

It would be wrong to interpret the curves of Fig. 3 as proving the presence of two protein components in solution. Fortunately, distinction between the two cases is easy. For, if the amount of protein used is changed, the position of O is unaffected, whereas that of R_s moves. It is therefore desirable that experiments of this sort should be done with at least two different amounts of protein.

Fig. 4 shows preliminary results obtained with β_1-lactoglobulin[5], which indicate that solutions of this protein contain only a single chemical component in equilibrium with two different solid phases, according to the salt concentration; similar results have been obtained with β_2-lactoglobulin.

This work was aided by a grant from the Agricultural Research Council.

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[1] Falconer, J. S., and Taylor, D. B., *Biochem. J.*, **40**, 835 (1946).
[2] Derrien, Y., *Biochim. Biophys. Acta*, **8**, 631 (1952).
[3] Smithies, O., *Biochem. J.*, **58**, 31 (1954).
[4] Edsall, J. T., "Advances Protein Chem.", **3**, 383 (1947).
[5] Aschaffenburg, R., and Drewry, J., *Nature*, **176**, 218 (1955).

A Critical Technique for Enzyme Cytochemistry

The accurate localization of an enzyme at the cellular level by a cytochemical technique requires a full investigation of artefacts due to diffusion of enzyme, reagents and reaction products. The classical superimposed-section technique does not have a sufficient resolving power to evaluate diffusion artefacts over the small distances inside a cell. A technique has been developed which enables the enzyme in small areas inside a cell in a tissue section to be

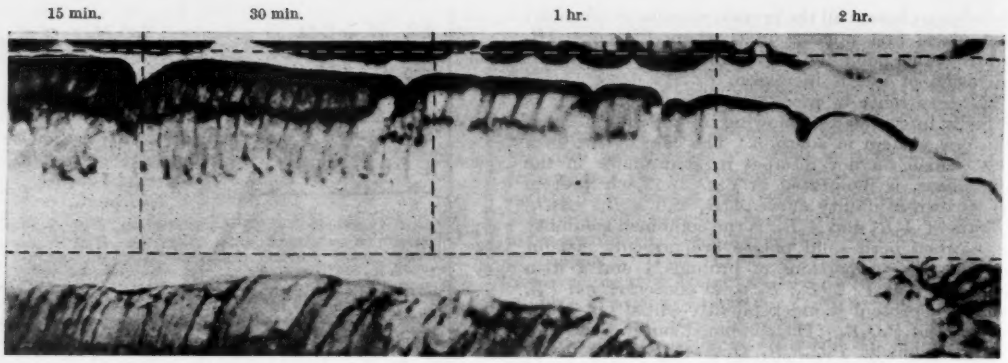

Fig. 1

inactivated. In this way diffusion during a cytochemical reaction can be investigated. The method makes use of the enzyme-inactivating action of the long wave-length ultra-violet light obtained from a glass-jacketed 250-watt B.T.H. mercury lamp. This is focused on the section mounted in water between two coverslips by an 8-mm. apochromatic objective. A mask in front of the lamp acts as the light source, and in this way slits or patterns of small holes can be focused on the section.

In this way areas of a few square microns, for example, a nucleus, can be inactivated. A suitable mask is made of heavy tin foil pricked by a fine glass needle, and mounted on a heat-resisting glass filter. Between the mask and the lamp are several heat filters and a removable intensity filter. Between the mask and the objective acting as a condenser is a cover slip at 45° to the optical axis which reflects in an auxiliary lamp used for taking a photograph of the section and the 'inactivated' spots. Such photographs are taken at intervals during the inactivation to check on movement of the spots. The coverslips holding the section must be firmly mounted and only a small area left unsupported around the section, otherwise the image of the mask may move during the period of irradiation, which for alkaline phosphatase may be 1–2 hr. Several sections besides the inactivated one are mounted on the coverslip and serve as controls. Studies on alkaline phosphatase have been carried out in collaboration with Prof. J. F. Danielli and Dr. J. H. Fodden, and will be published elsewhere. The technique has been to flatten frozen and dried tissue sections on to a coverslip using 95 per cent alcohol. The slip is dried in a desiccator, the wax removed by xylene, the section fixed in absolute alcohol for 15 min. and again dried in a desiccator. The section is then placed directly in water for the inactivating process, thus avoiding concentrations of alcohol likely to dissolve alkaline phosphatase.

The procedures described above should be applicable to many critical enzyme studies at a cytochemical level.

The apparatus is simple to set up, but needs critical adjustment. The coverslips should be the correct thickness for the condensing objective and the mask should be at a distance from the condenser corresponding to the correct tube-length for the lens. The numerical aperture of the illumination beam is kept at, or below, 0·6 to reduce scattered light in the specimen.

Fig. 1 shows a 4-μ section of frozen and dried rat duodenum, with a portion of one villus irradiated with a wide slit as indicated by the dotted line and for the times shown. After irradiation the section was incubated for 5 min. in the Gomori technique for alkaline phosphatase. The details appearing in black in the figure are caused by deposition of calcium phosphate: no counterstain was used.

I acknowledge the helpful interest of Prof. J. F. Danielli in this development.

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Crystalline Xylanase

Xylan is hydrolysed in animals, plants, and by a large number of micro-organisms. Sørensen[1] recently gave evidence that certain bacteria act on xylan to produce xylose-containing oligosaccharides and D-xylose. Whistler *et al.*[2] reported that an enzyme preparation from the medium of *Aspergillus foedidus* hydrolysed corn-cob xylan primarily to xylobiose with no production of D-xylose. An extract of the mould mycelium was separated into two fractions:

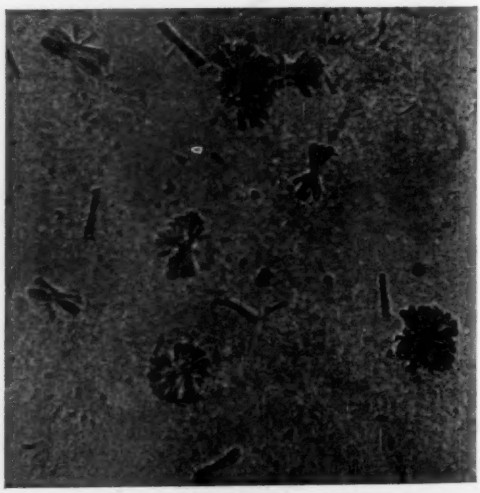

Fig. 1. Crystals of xylanase. (× 600)

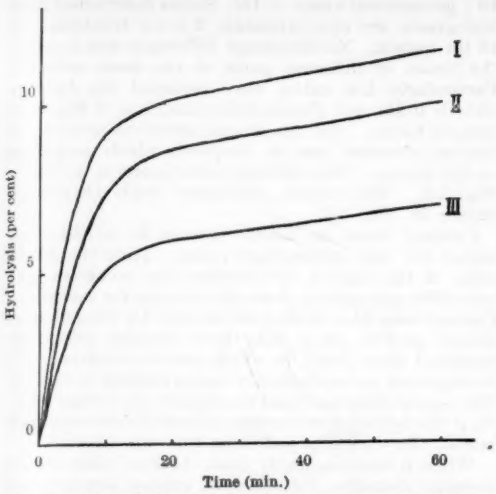

Fig. 2. Hydrolysis of xylan by crystalline xylanase: I, calcium and magnesium ions added; II, calcium ions only added; III, calcium and magnesium ions not added

one which hydrolysed xylan and the oligosaccharides to D-xylose without producing significant amounts of oligosaccharides, and one which hydrolysed xylan to a mixture of D-xylose and oligosaccharides.

From a medium of a *Bacillus* sp. we have crystallized an enzyme which hydrolysed xylan to xylobiose, xylotriose and higher xylose-containing oligosaccharides but produced no noticeable D-xylose.

The bacilli were grown in a medium containing xylan, meat extract, peptone and salts for seven days. 5,000 c.c. of the culture medium was collected and concentrated to 1,000 c.c. and 10 c.c. of 20 per cent basic lead acetate added. After centrifuging, ammonium sulphate was added to the supernatant solution to bring its concentration to 70 per cent saturation. The precipitate was dissolved in 250 c.c. of *M*/15 phosphate buffer (*p*H 6·0), and dialysed against distilled water. 25 c.c. of 1 per cent rivanol solution was added to the dialysed supernatant solution and the precipitate produced was discarded. The enzyme was precipitated from the supernatant solution by the addition of 500 c.c. of acetone and dried *in vacuo*. 520 mgm. of white powder was obtained. 300 mgm. of this powder was dissolved in 10 c.c. of distilled water and 3 c.c. of acetone was added. After removing the precipitate produced, another 2 c.c. of acetone was added and the solution held at 5° C. Crystals shown in Fig. 1 appeared within one day. The yield was about 30 mgm.

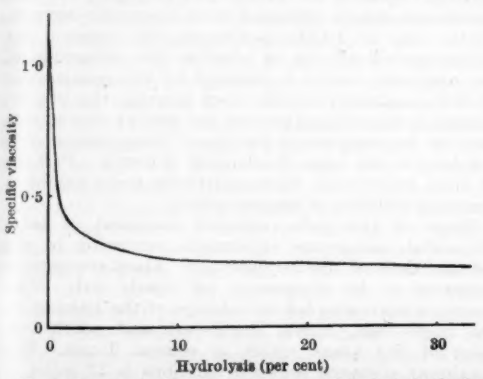

Fig. 3. Decrease in viscosity during enzymatic hydrolysis of xylan

The enzyme was activated by the presence of Ca^{++} and Mg^{++}. If the action of this enzyme on xylan was determined reductometrically and the degree of hydrolysis was plotted against time, the curves in Fig. 2 were obtained. The reaction evidently resolves itself into two phases with widely different velocities: an initial, rapid phase in which about 9 per cent of the xylosidic linkages of the substrate are ruptured and a second, considerably slower, phase showing no definite limit within a reasonable time. The initial phase is accompanied by an extremely rapid decrease in viscosity as shown in Fig. 3.

Paper-chromatographic analysis of the hydrolysates of xylan by this crystalline xylanase showed that xylobiose, xylotriose and higher xylose-containing oligosaccharides were the principal products. Xylose was not produced.

We wish to express our thanks to Prof. K. Yamafuji, of Kyushu University, for guidance.

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[1] Sorensen, H., *Phys. Plantarum*, **5**, 183 (1952).
[2] Whistler, R. L., and Masak, E., *J. Amer. Chem. Soc.*, **77**, 1241 (1955).

Radon Content of the Atmosphere

RECENTLY we reported raised levels of atmospheric radon during smoky or fog conditions[1]. It was also pointed out that radon was released into the atmosphere during the normal burning of coal. We have now carried out estimations of the radium contents of a series of representative samples of coals as used in Great Britain. The results of this analysis are shown in Table 1. The methods of estimation were the same as described previously.

Table 1

Source of coal sample	Purpose for which coal is used	Radium content (gm. $\times 10^{-12}$/gm. coal)
South Wales	Power stations	2·56
South Wales	Closed stoves	0·50
Durham	Blast furnace coke	3·16
Durham	Gas-making	2·02
Yorkshire	Domestic	1·65
Yorkshire	Gas-making	3·25
Northumberland	Power stations	2·20
Warwickshire	Domestic	0·70
Nottinghamshire	Domestic	2·10
East Fife	Power stations	0·55

The radium contents of the coals are in a narrow range of values and are similar to those described in the preliminary work. The absence of levels of a higher order suggests that the contribution of radon from this source does not represent a significant addition to the total atmospheric level.

Adsorption of radon on certain fractions of the atmospheric dust nuclei might be suggested as a possible mechanism for its retention in the surface atmosphere. Our experience with samples of atmospheric dust, however, has shown that the associated radioactivity corresponds, in terms of half-life, to the daughter products of radon and not to the active

gas itself. The explanation of the raised levels of activity is most likely to be made in terms of the special meteorological conditions associated with fog or smoke-laden atmospheres.

We are indebted to the National Coal Board for the coal samples and to Mr. A. M. Wandless for much useful information on the samples.

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[1] Anderson, W., Mayneord, W. V., and Turner, R. C., *Nature*, **174**, 424 (1954).

Occurrence of Cæsium in Fossils

The possibility of potassium – argon dating of fossils led to the spectrographic examination of a brachiopod (*Lingula*), a lamellibranch (*Gryphaea*) and a trilobite (*Calymene*) for potassium. The alkali metal spectra of *Calymene* showed such marked cæsium enrichment, relative to rubidium and potassium, that a rapid survey was made of the phylum Arthropoda. Two arachnids, four insects, four crustaceans and twenty-eight trilobites were analysed by a semi-quantitative method. To compare different species and genera of trilobites from a single horizon, collections were made from the Upper Silurian Wenlock Limestone at Dudley, Staffordshire. In order to check whether the sediment associated with the trilobites might have an unusual cæsium content many matrices adjacent to the fossils were analysed, collections of sediment also being made for this purpose at Dudley.

From inspection of the potassium and rubidium lines, the K/Rb ratio is not significantly different in the trilobites and enclosing sediments and is about the same as in sediments and igneous rocks. The Rb/Cs ratio was estimated with fair accuracy. This ratio gives a clearer indication of relative cæsium enrichment than the absolute amounts present, for which the reproducibility was poor ($\lambda' = 2$, Ahrens[1]). The Rb/Cs ratio is markedly lower in the trilobites (arithmetical mean = 3·9; geometrical mean = 2·4) than in the enclosing sediment (arithmetical mean = 19; geometrical mean = 15). Modes determined from histograms are approximately 2·5 for trilobites and 15 for matrix. No significant difference was noted in the ratios of different parts of the same trilobite. Particularly low ratios were recorded for *Deiphon* (Rb/Cs 0·36) and *Paradoxides* (Rb/Cs = 0·26), both spinose forms. The maximum (absolute) amount of cæsium recorded was in *Deiphon*, which contained ~ 250 p.p.m. This striking enrichment is shown in Fig. 1*A*. The matrix associated with *Deiphon* is shown in Fig. 1*B*.

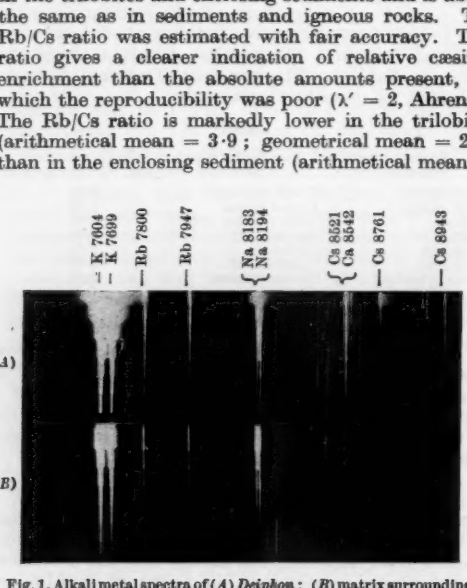

Fig. 1. Alkali metal spectra of (*A*) *Deiphon*; (*B*) matrix surrounding *Deiphon*

Canney[2] found an Rb/Cs ratio of 15 (arithmetical mean) for 323 sedimentary rocks. Thus the Rb/Cs ratio of the matrix surrounding the trilobites does not differ appreciably from the average for sediments. Cæsium may have been concentrated by the trilobites during growth, or it may have become selectively absorbed after death, in which case the matrix might be expected to be distinctly impoverished in cæsium. The results obtained tend to support the former view, or, if the cæsium enrichment of the trilobites was post-burial, the enclosing sediment was not affected.

While it has frequently been observed that certain metallic elements, for example, copper, are enriched in organisms, it is interesting to note, in the present case, strong enrichment of one alkali element relative to the others with similar chemical properties. The cæsium enrichment is perhaps connected with its large size (Cs^+ : 1·67 A.) and consequent low degree of hydration.

A spectrographic examination was also made of five genera of the phylum Brachiopoda. Of these, *Lingula* (the only chitinous form analysed) showed some cæsium enrichment.

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[1] Ahrens, L. H., "Quantitative Spectrochemical Analysis of Silicates" (Pergamon Press, London, 1954).
[2] Canney, F. C., *Bull. Geol. Soc. Amer.*, **63**, 1238 (1952).

Palæomagnetism of Chemical Sediments

Since previous observations of remanent magnetism of sedimentary rocks have been mainly confined to detrital deposits, we would like to report on new significant results obtained with chemical deposits. In the case of detrital sediments, the question has arisen sporadically as to whether the inclination of the remanent vector is changed by the realignment of the magnetic particles upon meeting the bottom surface in the settling process and also by movements later in the compaction process. This question does not hold in the case of chemical deposits. Perhaps of more importance, these particular rocks exhibit a desirable stability of magnetization.

Some of the rocks sampled consisted of large ellipsoidal, calcareous concretions occurring in the Barnett shale of Mississippian age. These concretions appeared to be syngenetic (or nearly so). Nine locations were sampled at outcrops of the Barnett on the north-west, north, north-east and south-west sides of the Llano uplift in central Texas. The maximum distance between locations is 73 miles.

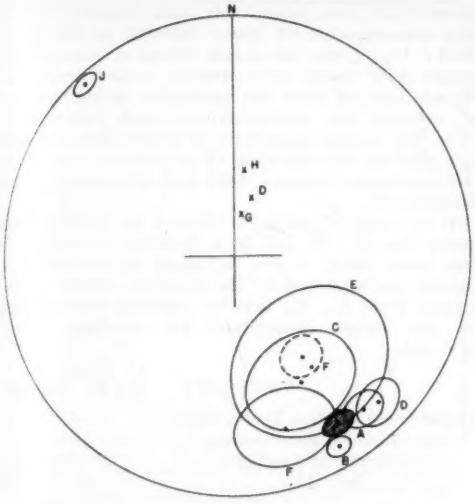

Fig. 1

Fig. 1 shows a lower hemisphere plot on a Schmidt projection of the magnetic polarization directions for the various locations labelled with capital letters; the Fisher circles of confidence at the 5 per cent significance-level are indicated with the corresponding letters. At locations *A*, *D* and *F* two concretions each were sampled; at *B*, three concretions and a limestone bed; at *C*, two limestone beds; at *E*, one concretion; and at *J*, one limestone bed. The crosses indicate averages as follows: one measurement from a weathered shale at *D*; two measurements from a concretion (not typical) at *G*; and three measurements from a limestone bed at *H*. These points are not considered in the analysis since they obviously indicate instability of magnetization of the rocks. The dashed circle is obtained from twenty-two measurements from ten shale samples at *F*. These data are also not considered since the magnetizations were weak and the vectors scattered; also, the shale is of detrital origin. The cross-hatched circle of confidence is found from a total of more than sixty measurements for all the samples indicated by solid circles in the south-east quadrant. Thus, from this average direction of magnetization and the usual dipole relationship, the position of the south (not seeking) magnetic pole is found to be at 39° N. latitude and 124° E. longitude. From eight measurements of the reversely magnetized limestone at *J*, the north pole is located at 42° N. latitude and 142° E. longitude. These positions are in good agreement with Carboniferous pole locations by others: Belshe[1], 36° N. latitude and 137° E. longitude, found from Carboniferous sediments in England; and Runcorn[1], 49° N. latitude and 120° E. longitude, found from Pennsylvanian sediments in Arizona.

As to the stability of magnetization of the Barnett in geological time, we present the following favourable evidence: (1) The direction of magnetization is drastically different from that of the present Earth's field. (2) With a few exceptions, the data from widely separated locations in the uplift area agree. (3) The pole positions agree with those found by others from more widely separated locations. (4) When sense is disregarded, the direction of reverse magnetization at *J* agrees with the direction obtained from the other samples (we are not committed to a 'normal' direction). (5) There is an indication of stability, though not conclusive, obtained from two samples of sharply tilted strata[2] near faulting thought to have occurred in Pennsylvanian time. (6) With a few exceptions, there is good agreement between the results obtained from a variety of lithology: limestones, shales, limy shales and concretions. Regarding point (4) above, a study of thin sections of the Barnett samples, including those reversely magnetized, indicates that the most likely ferromagnetic mineral present is hæmatite, which is formed as a result of oxidation of syngenetic pyrites. No differences were noted which might give credence to a magnetization of the rock in the reverse direction to the Earth's field in one case and not in the other.

Both the field evidence and the petrographical observations support the conclusion that the calcareous concretions are syngenetic. They are certainly formed as a result of chemical processes and they contain very little detrital matter. Therefore the amount of detrital ferromagnetic minerals that could be present must be very small indeed and could scarcely account for the magnetic intensities observed. This seems to be excellent evidence that the ferromagnetic minerals are formed through chemical processes and probably acquire their remanent magnetism during these processes. This we feel to be a significant conclusion.

Other Carboniferous rocks have been sampled, and we hope to give a more detailed report in a later publication.

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[1] Runcorn, S. K., *Nature*, **176**, 505 (1955).
[2] Graham, J. W., *J. Geoph. Res.*, **54**, 131 (1949).

Angle of Spread of Free Jets

The value of the angle of spread of free turbulent jets has been of great interest to theoretical workers, and its practical application has become important to engineers in the field of combustion engineering. When such a jet of fluid is injected into quiescent surroundings the original kinetic energy of the jet is gradually dispersed in the turbulent mixing region of the jet. The pressure in the jet is very nearly the same as in the surroundings; but a surface of discontinuity separates the stream and the neighbouring fluid. The boundary is well defined apart from slight local instability. Surrounding fluid is entrained at the boundary so that the velocity of the jet decreases while the mass of fluid increases, the momentum remaining constant. In this way the jet spreads in the form of a cone having a well-defined angle. Measured values of the jet half-angle have been variously reported from 7° to 20°. Using Prandtl's hypothesis, Tollmien[1] calculated the jet half-angle to be 12°. Recently, a new measurement of this angle was made at Sheffield, and the influence of jet fluid density investigated.

During the development of a technique for introducing a buoyancy effect into furnace models, as previously reported[2], a jet of magnetite slurry was injected into a large, slowly moving mass of water in a 'Perspex' box. The slurry, being intensely black,

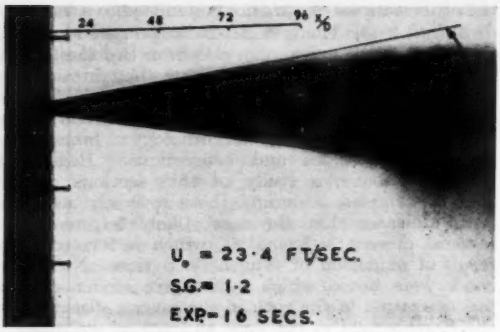

Fig. 1. Angle of spread of free jet; density ratio 1·2

provided excellent photographs of turbulent jets, such as the one shown in Fig. 1, from which the jet half-angle was deduced to be 8·5°. This agrees with the value reported by Binnie[3] for a water jet, but is less than the results quoted for gaseous systems. This result was constant for several values of the nozzle velocity and the exposure time of the photographs. Although the jet was fired horizontally, the density difference between nozzle fluid and surrounding fluid did not affect the early trajectory, where the angle was measured, as the half-angles measured above and below the horizontal were found to be equal.

In the theoretical analysis of the path taken by jets of initial density different from their surroundings, it is important to know if the jet angle, and hence the spread functions of velocity and concentration, vary with the density ratio. Measurements of the jet angle were made with nozzle fluid of specific gravity ranging from 1·0 to 2·0, and no variation in the jet angle was found (Fig. 2). This contradicts the results of Keagy and Weller[4], who measured the jet angle for vertical streams of carbon dioxide, nitrogen and helium expanding in air and found a considerable variation.

By writing down the conservation laws, it is possible to derive the following approximate expressions for axial values of velocity and concentration in a free jet at large values of x.

$$U_m = K_1 U_0 \frac{D}{x} \sqrt{\frac{\rho_0}{\rho_s}}$$

$$C_m = K_2 C_0 \frac{D}{x} \sqrt{\frac{\rho_s}{\rho_0}}$$

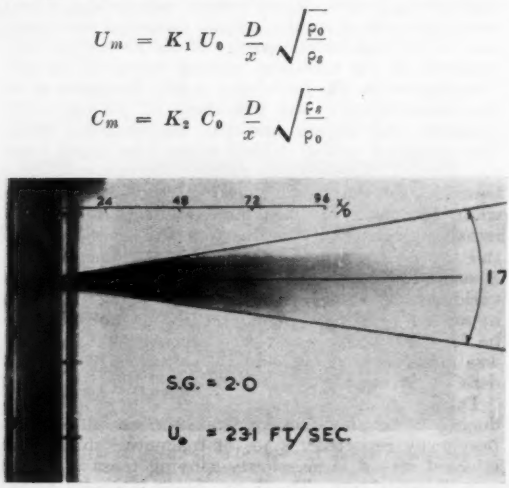

Fig. 2. Free jet; density ratio 2·0

where U_m, C_m are, respectively, axial values of velocity and concentration of tracer inserted in the nozzle fluid; U_0, C_0 are the initial values of velocity and nozzle fluid tracer concentration respectively; K_1, K_2 are derived from the particular radial functions of velocity and concentration used, respectively; D is the nozzle diameter; x is the distance along the axis in the direction of projection; ρ_0, ρ_s are the densities of nozzle fluid and surrounding fluid, respectively.

If the angle of spread is affected by density differences then K_1, K_2 will be a function of ρ_0/ρ_s. On the other hand, if the jet angle is unaffected by density, as suggested by the magnetite slurry experiments, then K_1, K_2 will be constant and identical to the values determined for constant density systems.

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[1] Tollmien, W., *Z. angewandte Math. und Mech.*, **6**, 468 (1926).
[2] Horn, G., and Thring, M. W., *Nature*, **175**, 1081 (1955).
[3] Binnie, A. M., *Engineering*, **153** (2) (1942).
[4] Keagy, W. R., and Weller, A. E., Battelle Mem. Inst., Columbus Ohio (1949).

Comparative Rates of the Slow Combustion of Coke in Oxygen and Nitrogen Dioxide

Mainly to assist in understanding the reactions of carbons with oxygen, there have been a number of studies of the kinetics of the reactions of solid fuels with nitrous oxide[1–3]; but we are unaware of any comparable work with nitrogen dioxide. This compound, which has been shown to influence the decomposition and smoke-producing tendencies of coals[4,5], is of special interest as an oxidant in view of the comparatively easy thermal dissociation probably producing oxygen atoms in the primary stage:

$$NO_2 \rightarrow NO + O$$

It is also well known as a sensitizer of several gas-phase combustion reactions[6], and it is conceivable that, when introduced into the carbon/oxygen system, it could act as a catalyst and/or react separately with carbon.

Preliminary studies in these laboratories have shown that the additions of up to 1 per cent by volume of nitrogen dioxide to an air stream fed to a column composed of a high-temperature metallurgical coke maintained at 480 ± 2° C. produced a marked increase in the rate of gasification of the sample (Fig. 1). At 1 per cent nitrogen dioxide addition, the rate is about 56 per cent greater than in air only, although the 'available' oxygen in this amount of nitrogen dioxide is only 0·024 of that contained in the air stream. Further experiments indicated that the

Table 1. Relative Rates of Reaction of Coke with Several Gas Mixtures (480° ± 2° C.)

Reaction of coke with	Relative rate
Air	1·00
Air + 1 per cent NO_2	1·58
99 per cent N_2 + 1 per cent NO_2	0·57

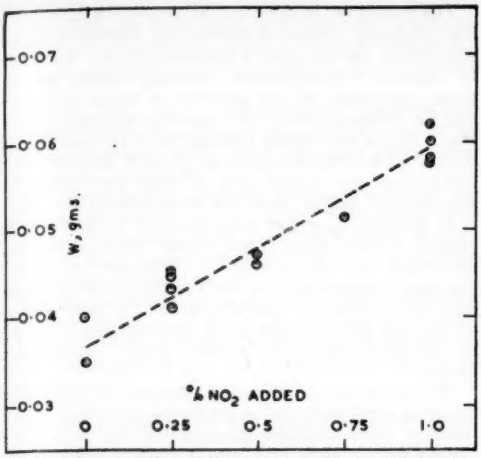

Fig. 1. Influence of NO_2 additions on the weight loss (W) of coke samples exposed to an air stream for 30 min. Initial weight of coke, 2·45 gm.; air velocity, 600 c.c./min.; coke size, 10–14 B.S.S.; coke temperature, 480 ± 2° C.

increased rates of reaction shown in Fig. 1 are due to a separate reaction between nitrogen dioxide and the coke, that is, the addition of nitrogen dioxide does not appear to influence the rate of the carbon/oxygen reaction; this was shown by a comparison of the reactivity of the three mixtures, air, air + nitrogen dioxide and nitrogen + nitrogen dioxide, towards the coke, the relative rates of reaction in each case being given in Table 1.

Consideration of the rate measurements of Bodenstein and Ramstetter[7] for the homogeneous thermal decomposition of nitrogen dioxide in the temperature-range 320–380° C. leads to the conclusion that in the present experiments at 480° C. with a catalytic surface (coke) present, freshly formed oxygen is the effective gasifying agent. Since this oxygen reacts so rapidly compared with the normal gas, it is probable that it is in the atomic form.

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[1] Shah, M. S., *J. Chem. Soc.*, 2661 (1929).
[2] Strickland-Constable, R. F., *Trans. Farad. Soc.*, **34**, 1374 (1938).
[3] Madley, D. G., and Strickland-Constable, R. F., *Trans. Farad. Soc.*, **49**, 1312 (1953).
[4] Johnson, G. W., and I.G. Farbenindustrie, British Patent No. 485,461 (1936).
[5] Billington, A. H., *Fuel*, **33**, 295 (1954).
[6] See, for example, Semenov, N., "Chemical Kinetics and Chain Reactions", 234 (Oxford, 1935).
[7] Bodenstein, M., and Ramstetter, H., *Z. phys. Chem.*, **100**, 68 (1922).

Instability of Uniform Concentration Conditions in Suspensions under Shear

In an earlier paper by one of us[1] it was shown theoretically that in a suspension under shear the action associated with an isolated suspended particle will be a minimum when the particle follows the streamline characterized by minimum velocity gradient. The principle of least action requires that a particle initially situated at a point in a velocity field at which the gradient is not a minimum should move with a component of motion normal to the direction of flow towards regions of lower velocity gradient. In a subsequent paper[2] direct evidence of this component was adduced from a study of the motion of streams of suspended particles.

The existence of this component points to the conclusion that, during the shearing of a suspension, the motions of the suspended particles lead to a progressive increase in their concentration in those regions where the rate of shear is least and a diminution of concentration where the highest rates of shear prevail. Preliminary experiments designed to investigate variations of concentration during shear have now been carried out, and evidence of the effect predicted is given below.

The apparatus used in these experiments consisted of a co-axial glass cylinder arrangement in which the inner cylinder was fixed and the outer was rotated by means of a variable-speed motor. The inner cylinder, which was a glass rod of 0·6 cm. diameter, was arranged with its lower end beneath the surface of a shallow pool of mercury contained in the outer cylinder. The latter cylinder was a glass tube of internal diameter 4·9 cm., and throughout the experiments its rate of rotation was 2·1 rev./sec. The values of these quantities are, however, in no case critical.

The suspension employed consisted of sieved polystyrene beads of mean diameter 181μ and of range ± 30μ, suspended in an aqueous sucrose solution of the same density. The concentration of the suspension was 0·025 gm./cm.^{3} and that of the solution 0·155 gm./cm.^{3} of distilled water. The depth of the suspension used was 21·0 cm. and its temperature during the experiment was 13° C.

Fig. 1 shows the appearance of the suspension two and a half hours after switching on the apparatus. It is clear from this that the effect of shearing the suspension is to develop concentration gradients across the annular space such that the concentration falls to a very low value near the outer wall of the apparatus. This condition remains stable indefinitely.

The concentration variations which gradually develop during the shearing of a suspension in a non-uniform velocity field, it is suggested, are fundamental to the phenomena associated with anomalous viscosity. It would appear that the condition of uniform

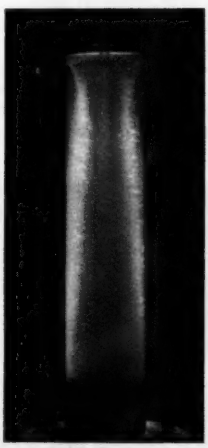

Fig. 1. Concentration variations in a suspension under shear

concentration of such disperse systems under shear is unstable.

We are indebted to Dr. J. J. P. Staudinger, of Messrs. British Resin Products, Sully, Glam., who provided the polystyrene beads, and to Mr. R. L. Powell, of the staff of this College, who took the photograph.

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[1] Starkey, T. V., *Brit. J. App. Phys.*, **6**, 34 (1955).
[2] Starkey, T. V., *Brit. J. App. Phys.*, **7**, 52 (1956).

Electron Bombardment of Counting Diamonds

The response of six diamonds as conduction counters for α- or β-radiation was determined, using as a criterion the maximum pulse-height versus applied-field curve obtained under conditions of minimum polarization. Without removal from their holders, the diamonds were then exposed to electron bombardment from the 15 MeV. linear accelerator at St. Bartholomew's Hospital Medical College, the counting response being redetermined after each successive bombardment. The electron beam from the accelerator passed through a water collimator. The diamond holders were cooled by water, and the overall temperature of the diamonds was kept below 70° C. during the bombardment. Radioactivity induced in thin strips of copper was used for the routine electron flux dosimetry, the absolute flux estimates being obtained by comparison with calorimetry measurements.

In each of the six counting diamonds bombarded the counting pulse heights progressively decreased with increasing bombardment flux. After a total flux of about 4×10^{16} electrons per cm.^{2} delivered at a rate of 3×10^{13} electrons per cm.^{2} per sec., the counting response was barely detectable, and the diamonds were perceptibly bluish-green in colour. In some specimens the insulation resistance also decreased after bombardment. Two non-counting diamonds were also bombarded and became bluish-green after about the same total electron flux.

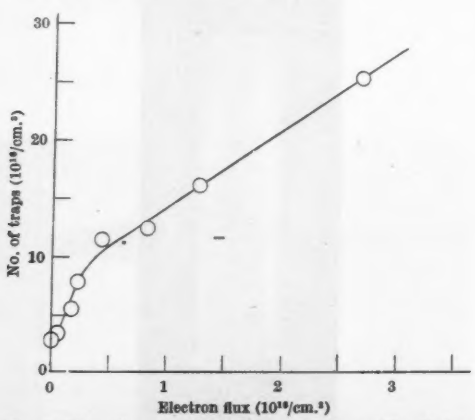

Fig. 1. Formation of additional traps in diamond by electron bombardment

The reduction in counting response is attributed to the trapping effects of additional vacant sites and interstitial carbon atoms introduced into the lattice by electron bombardment. Making certain assumptions, estimates of the number of traps introduced can be obtained from the counting response curves. Fig. 1 shows the typical increase in trap concentration with total bombardment flux. In each instance it was found that the initial rate of trap production was significantly higher than the subsequent rate. There is at present no direct experimental evidence of the causes of this effect; but some form of radiation annealing and the formation of clusters of defects, perhaps preferentially in the vicinity of barrier layers, may be suggested as possible factors. A small amount of thermal annealing at room temperature could also be detected after the lower total bombardment fluxes.

The effect on the counting response of high-energy electron bombardment is generally similar to that of neutron bombardment as reported by Benny and Champion[1]. However, the primary damage produced by electrons should be single or small groups of vacancies and interstitial atoms, whereas neutron bombardment can also give rise to larger disordered regions.

A fuller account of these experiments will be given elsewhere.

We are indebted to Dr. F. C. Champion for helpful advice and to Prof. J. Rotblat for facilities provided at St. Bartholomew's Hospital Medical College.

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[1] Benny, A. H. B., and Champion, F. C., *Proc. Roy. Soc.*, A, **234**, 432 (1956).

A New Complex Phase in a High-Temperature Alloy

The grain boundary phase (Fig. 1) in Allegheny-Ludlum Steel Corporation's A-286 alloy has been separated electrolytically and examined by X-ray diffraction. (The nominal composition of this alloy is 0·05 per cent carbon, 15 per cent chromium, 26 per

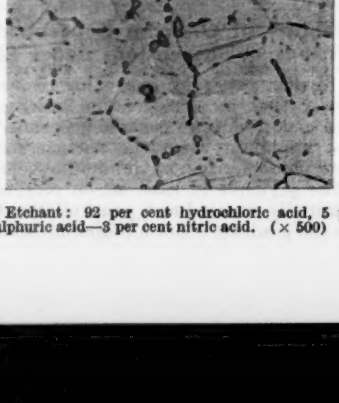

Fig. 1. Etchant: 92 per cent hydrochloric acid, 5 per cent sulphuric acid—3 per cent nitric acid. (× 500)

cent nickel, 1·15 per cent molybdenum, 0·50 per cent silicon, 53·5 per cent iron, 2·0 per cent titanium, 0·17 per cent aluminium, and 0·2 per cent vanadium.) This new constituent has been arbitrarily designated *G* phase.

Residues from several alloys having various heat treatments below the solution temperature (1,000° C.) contained *G* phase, which gave identical inter-planar spacings and intensities.

Semi-quantitative chemical analyses indicate the predominant element to be nickel with appreciable amounts of titanium and silicon and some of iron. This phase is more acid-resistant than TiC, presumably owing to the silicon content.

Microscopic studies show a direct relation between the silicon content of the alloy and the abundance of *G* phase, which together with the chemical results indicate that silicon plays a fundamental part in its existence.

Table 1. DIFFRACTOMETER DATA ON *G*-PHASE POWDER USING COPPER *Kα* RADIATION

G phase ($a = 11{\cdot}20$ A.)			$Cr_{23}C_6$ ($a = 10{\cdot}64$ A.)
$h^2+k^2+l^2$	Interplanar spacing (A).	Intensity (c.p.s.)	Intensity
4	5·60	14	—
8	3·98	34	—
16	2·80	66	*VW*
20	2·50	79	*M*
24	2·285	134	*M+*
27	2·154	635	*VS*
32	1·977	556	*MS–*
35	1·890	162	*MS–*
36	1·865	101	*M*
40	1·770	34	*VW*
43	1·708	66	*W*
44	1·688	45	*MW+*
59	1·458	21	—
64	1·399	16	*W–*
72	1·320	86	*S–*
75	1·292	56	*MS*
83	1·229	43	*MW*
84	1·220	23	—
91	1·174	23	—
96	1·142	34	*MS*
99	1·125	79	*M*
107	1·082	22	—
108	1·077	23	—

The accompanying table lists the interplanar spacings measured from a diffractometer recording and integrated intensities above background (240 c.p.s.) determined by the time to register 2^{16} counts. The $(h^2+k^2+l^2)$ values are those of a face-centred cubic lattice with parameter $a_0 = 11{\cdot}20$ A. The photographic powder patterns with copper $K\alpha$ radiation are unusually clear and contain as many as fifty-five lines, all of which can be indexed on the face-centred cubic lattice. There are evidently no systematic absences other than those imposed by face-centred symmetry; hence, the possible space groups are F_{23}, Fm_3, F_{432}, $F_{\bar{4}3}m$, and Fm_3m. This space group limitation rules out the η-carbide structure (Fd_3m), but not that of the $M_{23}C_6$ carbide (Fm_3m); however, the lattice parameters and X-ray intensities of the latter, which are also listed in the table, do not compare favourably with those of *G* phase. This phase, then, appears to have a new structure.

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Primary Action of X-rays on Lysozyme

THERE is a number of unsolved problems concerning the effect of irradiations on smaller structures of living systems, such as proteins and protein complexes. Many researches have recently been carried out by irradiating enzymatic and non-enzymatic proteins; but most of the results obtained are not quite clear and are of only relative interest, especially if we consider the following points: (1) the effect of irradiations has been studied on diluted and concentrated protein solutions; (2) when proteins have been irradiated in the dried state, the preparations employed contained some impurities which have a protective action.

Rajewsky[1–3] has worked on these problems for some years; and, at present, we are carrying out in his Institute some investigations with the aim of finding out how X-rays act primarily on protein and amino-acid molecules.

The results given in this preliminary communication are concerned only in what follows on the direct action of X-rays on lysozyme. The reason why we have chosen lysozyme is that this protein is very easily purified and crystallized, it is one of the smaller protein molecules and it possesses well-known biological activity. To prevent complications by the action of free radicals of the solvent, all irradiations have been carried out on dry material.

Lysozyme, crystallized according to Alderton and Fevold[4], has been irradiated with soft X-rays in 'Dermopan' apparatus (beryllium window; 45 kV.; 25 m.amp.; at distance of 2 mm. from the window, 1 million r. per minute) and different times of exposure were made to give doses between 2 million r. and 5 million r.

After irradiation the protein was hydrolysed with 5 *N* hydrochloric acid at 100° C. for 18 hr.; the hydrochloric acid was removed in vacuum and the composition was examined with the aid of high-voltage paper electrophoresis. The technique was essentially that of Wieland[5].

A typical pherogram obtained from control (not irradiated) and irradiated lysozyme is shown in Fig. 1.

Here there is good evidence of the modifications induced on lysozyme after irradiation: it is clear that significant changes occur in composition of the acid fraction of irradiated lysozyme; but the most interesting result is the occurrence of several fractions on the basic side of the pherogram, which are moving faster than the fastest basic amino-acid (lysine). In Fig. 1 it is also possible to observe a decrease of lysine in the irradiated lysozyme.

To learn something about the neutral amino-acids of the irradiated lysozyme, in some experiments, after

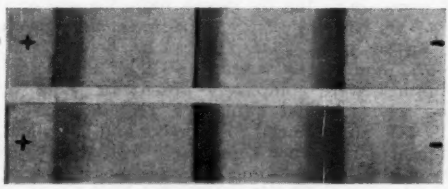

Fig. 1. Electrophoretic behaviour of control (*a*) and 5×10^6 r. irradiated (*b*) lysozyme hydrolysate. Equal amounts of nitrogen content for both samples. *p*H 6·0 buffer; pyridine 10 per cent, glacial acetic acid 1 per cent in water. 1,500 V.; potential gradient 40 V./cm. Running time 60 min. The fractions have been revealed with ninhydrin

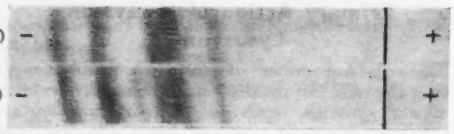

Fig. 2. Electrophoretic separation of neutral amino-acids from control (*a*) and 5×10^6 r. irradiated (*b*) lysozyme hydrolysate. Equal amounts of nitrogen content for both samples. 1,500–2,000 V.; potential gradient 40–55 V./cm. Running time 80–60 min. The fractions have been revealed with ninhydrin. *p*H 1·9 buffer: glacial acetic acid 15 per cent, formic acid 5 per cent in water

separation of the basic and the acid fractions, we eluted the neutral fraction from the paper. The amino-acids of this fraction have been separated again by high-voltage paper electrophoresis; Fig. 2 shows the results obtained in one of these pherograms.

It is of interest to note the occurrence of at least one single new compound between the neutral amino-acids of irradiated lysozyme.

From the results reported above it is evident that after irradiation of a protein like lysozyme the amino-acids are changed in some very complex way, for example, α-ketoacids and lactones of α-amino-acids have also been found in the hydrolysate of irradiated lysozyme.

Detailed results on the chemical composition of irradiated lysozyme, its physicochemical properties and its enzymatic activity will be published elsewhere.

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[1] Rajewsky, B., *Strahlenther.*, **33**, 362 (1929).
[2] Rajewsky, B., *Strahlenther.* (in the press).
[3] Pauly, H., and Rajewsky, B., *Strahlenther.* (in the press).
[4] Alderton, G., and Fevold, H. L., *J. Biol. Chem.*, **164**, 1 (1946).
[5] Wieland, Th., *et al.*, *Angew. Chem.*, **67**, 257 (1955).

Prevention of Psychological Effects of *d*-Lysergic Acid Diethylamide (LSD 25) by its 2-Brom Derivative (BOL 148)

In view of the blocking effect often exerted by the close chemical analogue of a pharmacologically specific agent, we tried to determine whether the psychological symptoms induced by D-lysergic acid diethylamide (LSD 25) could be influenced by one of its psychologically inactive derivatives. The 2-brom derivative of LSD 25 (BOL 148) exerts no psychological effects[1].

Six volunteers who showed definite mental symptoms when given 50 or 75 μgm. LSD 25 in the preceding control experiment were pretreated with 2–3 mgm. BOL 148 by mouth daily for one or two days. On the day of the experiment they received one further mgm. BOL 148 1–3 hr. before LSD 25 (50–75 μgm.) was administered. Psychological symptoms were completely absent in those three cases who received two days pretreatment with BOL 148, and reduced to abortive and short-lasting changes in the other three cases who were treated only on the day preceding the experiment. The latter showed some subjective difficulty in concentration only, which could not be established objectively. In all cases, euphoria, depersonalization and all marked sensory symptoms observed in the control experiment did not appear.

In contrast, 0·5 mgm. or 1·0 mgm. BOL 148 injected intravenously in another four volunteers at the height of LSD 25 symptoms did not produce any noticeable or persistent changes in the symptoms of the LSD intoxication.

The fact that a substance closely related to LSD 25 can block the mental disturbances induced by it may throw some light on the mode of action of the drug.

We are indebted to Dr. H. Holgate, of Messrs. Sandoz Products, Ltd., for a generous supply of drugs LSD 25 and BOL 148.

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[1] Cerletti, A., and Rothlin, E., *Nature*, **176**, 785 (1955).

A Method for following Lipolysis induced by Heparin

The heparin clearing effect on postprandial lipæmic turbidity of blood serum has been demonstrated by Hahn[1]. Recently, it has been shown that heparin clearing is accompanied by the formation of a new electrophoretic component[2] and by an increase in free fatty acid[3]. That this process is of an enzymatic nature is now beyond doubt[4]. Since higher fatty acids are known to cause a depression of the second part of the polarographic protein double wave of albumin[5,6], the effect of heparin clearing on the polarographic behaviour of human blood serum was investigated because it has been shown that the polarographic effect of higher fatty acids on human blood serum can be accounted for only by the interaction of serum albumin with the fatty acids[6]. It was found that the intravenous administration of 0·5 ml. of 5 per cent heparin to six postprandial lipæmic humans as well as to six fasting subjects causes a marked depression of the second part of the polarographic protein double wave. Tables 1, 2 and 3 give the heights of the second wave in one individual which is representative of the entire group. In all cases the results were qualitatively identical.

Table 1

	Height of second wave in mm. (from cobalt wave)
Fasting	48
3 hr. after fatty meal	50
5 min. after 0·5 ml. of heparin *in vitro*	29
Fasting	58
5 min. after 0·5 ml. of heparin *in vitro*	44

Heparin added *in vitro* to blood serum does not show such an effect. The onset of the heparin effect is extremely rapid and its polarographic result can still be demonstrated in blood samples drawn 15 min. after heparin injection (Table 2).

Table 2

	Height of second wave in mm. (from cobalt wave)
Fasting	54
3 hr. after fatty meal	55
5 min. after 0·5 ml. of heparin *in vitro*	44
10 min. after 0·5 ml. of heparin *in vitro*	41
15 min. after 0·5 ml. of heparin *in vitro*	41

The technique of this procedure is extremely simple, consisting in taking a polarographic recording of a blood serum dilution 1 : 400 in Brdička's cobaltic solution (0·001 *M* $[Co(NH_3)_6]Cl_3$, 0·1 *M* NH_4Cl, 0·1 *M* NH_3). The effect of intravenous protamine

Table 3

	Height of second wave in mm. (from cobalt wave)
Fasting	60
3 hr. after fatty meal	66
5 min. after 0·5 ml. of heparin *in vitro*	42
5 min. after 5 ml. of 1 per cent protamine *in vitro* (that is, 10 min. after heparin)	55
Fasting	54
5 min. after 5 ml. of protamine	56

following heparin administration is also quite striking (Table 3).

Protamine given by itself does not show any effect. The *in vitro* effect of heparinized individuals on lactescent blood serum can also be demonstrated by this method. Since the existing methods of studying heparin-induced lipolysis are rather tedious and cumbersome, the method reported here may prove of some value. A considerable advantage for the physiological application of this method is the minute amount of blood serum required for polarographic measurements.

The mechanism of the phenomena described and the results of their application in the study of the physiology and pathophysiology of lipid transport will be reported in detail elsewhere.

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[1] Hahn, P. F., *Science*, **98**, 19 (1943).
[2] Herbst, F. S. M., and Hurley, N. A., *J. Clin. Invest.*, **33**, 907 (1954).
[3] Robinson, D. S., Jeffries, G. H., and French, J. E., *Quart. J. Exp. Physiol.*, **39**, 165 (1953).
[4] Korn, E. D., *Science*, **120**, 399 (1954); *J. Biol. Chem.*, **215**, 1 (1955).
[5] Reichl, D., *Chem. Listy*, **49**, 1886 (1955).
[6] Marha, K., *Chem. Listy*, **49**, 1896 (1955).

Osmotic Pressure in the Intestine of the Cow

Many investigations of the osmotic pressure in the intestine have been carried out. In those performed on laboratory animals it always turned out that, in the small as well as in the large intestine, there is isotony with the blood.

In our investigation the osmotic pressures of the press-juice of the faeces and of the intestinal content of the cow have been determined. The faecal juice was obtained by pressing the faeces in a membrane press. The freezing-point depression method was used for measuring the osmotic pressure.

With fifty cows the mean value of the freezing-point depression in the press-juice of the faeces

Table 1

	Freezing point depression (°C.)
Experiment 5	
b, rennet-stomach (abomasum)	0·549
a, duodenum	0·684
c, middle small intestine	0·714
j, caecum	0·620
h, beginning of large intestine	0·530
f, middle of large intestine 1	0·489
g, middle of large intestine 2	0·449
d, end of large intestine	0·398
Experiment 6	
f, rennet-stomach (abomasum)	0·490
a, duodenum	0·588
b, middle of small intestine 1	0·951
c, middle of small intestine 2	0·822
d, end of small intestine	0·628
n, caecum	0·606
m, beginning of large intestine	0·549
l, middle of large intestine 1	0·388
k, middle of large intestine 2	0·364
j, middle of large intestine 3	0·339
g, end of large intestine	0·375

appeared to be 0·350 deg. C., the extremes being 0·240 and 0·430 deg. C. The freezing-point depression of the cow's blood is 0·560–0·590 deg. C. The press-juice of the cow's faeces is therefore rather strongly hypotonic with regard to the blood. From the data in the literature, however, isotony with regard to the blood had been expected.

Afterwards, with six cows, the osmotic pressure in different parts of the intestine was determined. In Table 1 the results of two of these determinations are given.

The content of the abomasum is slightly hypotonic with regard to the blood. In the small intestine, however, mostly rather strong hypertony occurs; but in the end of the small intestine and in the caecum isotony with regard to the blood is practically re-established. In the large intestine the contents gradually become hypotonic. It is clear that this last-mentioned fact may be of great importance for the mineral balances and the mineral metabolism of the cow.

We conclude, therefore, that the generally accepted tendency of the intestinal content towards isotony with the blood does not hold for the cow.

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Deficient Water-binding in Pathological Horny Layers

The pathogenesis of most scaling skin conditions is obscure. Although it has been often assumed that abnormal processes of keratinization play a major part, recent work has emphasized the importance of the water-soluble components of the horny layer. These components contribute to the water-binding ability and pliability of the normal skin surface[1]; their amounts are reduced in psoriatic scales[2] and skin[3].

We have determined the water-uptaking capacity at 100 per cent relative humidity and the amino-nitrogen content of normal horny layer (callus) and of scales from six patients with psoriasis and two patients with ichthyosiform erythroderma, a congenital scaling skin disease. Determinations were made in pulverized, ether-defatted, non-hydrolysed horny material, in the aqueous extracts and the water-insoluble residue. Callus took up about 50 per cent more water than the pathological specimens (28 per cent versus 19 per cent). After extraction with water, the water-binding ability of all the residues became practically the same (17–19 per cent).

The assumption that the water-soluble components were responsible for the decreased water-binding ability of the pathological specimens was further supported by precipitating these substances from the extracts with an excess of acetone and determining their water-binding capacity. The acetone-precipitable material from the pathological scales took up considerably less water than their normal counterparts (47–49 per cent versus 114–116 per cent).

The most important dialysable water-binding components of the horny layer are free amino-acids[4,5]. The diminution of the free amino-nitrogen in pathological scales is confined to the water-soluble portion

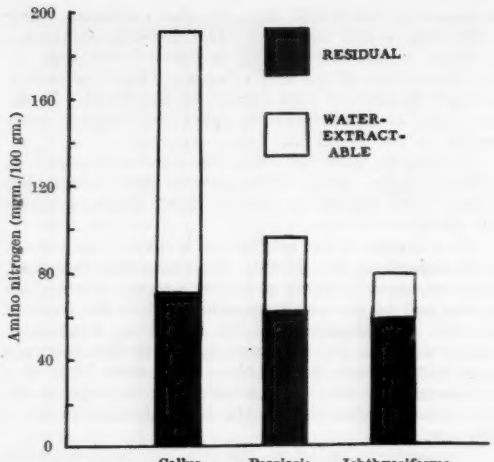

Fig. 1. Free amino-nitrogen in non-hydrolysed calluses (3 specimens), psoriatic scales (6 patients) and scales from a congenital scaling disease (2 patients)

of the scales. The amino-nitrogen content of the residue, obtained by calculation and, in most cases, by actual estimation, was virtually the same in normal and pathological specimens (Fig. 1).

These findings suggest that in these scaling conditions the main fault may not lie in the keratinous portion of the horny layer or in the process of keratinization. The decrease in the free amino-acids may result from an abnormal protein metabolism in the differentiating epidermal cells. The previously reported high —SH content of psoriatic scales[6,7] may also be an expression of such an abnormal metabolism in the non-keratinizing portion of the cells, because these groups can be extracted with water or detergents.

Removal of the major hydrophilic component of the horny layer by a combination of lipid solvents and water results in decreased water-binding capacity and brittleness[1]. When, in certain pathological conditions, these substances are diminished, the horny layer may have a different appearance. Although the reported changes are not in themselves specific for any scaling disease, their combination could be distinctive for certain conditions, for example, in psoriasis with the simultaneous occurrence of high —SH values and low water-extractable amino-nitrogen. Further identifying features may be revealed by studying the amino-acid composition of the water-soluble portion of various pathological cornified epithelia. Studies of this nature are in progress. This study was supported by U.S.P.H.S. Grant *G*-4257 *C*.

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[1] Blank, I. H., *J. Invest. Dermat.*, **21**, 259 (1953).
[2] Grüneberg, Th., and Szakall, A., *Arch. Klin. Exp. Dermat.*, **201**, 361 (1955).
[3] Schmidli, B., and Paschoud, J. M., *Dermatologica*, **110**, 323 (1955).
[4] Matoltay, A. G., and Balsamo, C. A., *J. Biophys. Cytol.*, **1**, 339 (1955).
[5] Spier, H. W., and Pascher, G., *Arch. Dermat. u. Syph.*, **199**, 411 (1955).
[6] Zingsheim, M., *Deut. Med. Wchschr.*, **77**, 1630 (1952).
[7] Van Scott, E. J., and Flesch, P., *Arch. Dermat. Syph.*, **70**, 141 (1954).

Mitosis in Migrating Epithelial Cells

It is generally believed that the absence of mitotic activity in migrating epithelial cells is one of the characteristic features of repair in epithelia. Migration alone is held to be responsible for epithelialization in the early stages of healing. Increased mitotic activity occurs later at some distance from the wound margins, and spreading cells are considered to exhibit mitosis only after they have become firmly fixed to the underlying tissues.

Recent studies in the cat have shown that certain epithelial cells do undergo mitotic division when migrating. Observations on regenerating transitional epithelium in the urinary bladder[1] revealed that, within two days of creating an excision ulcer in the mucosa, increased mitotic activity was present not only in the epithelium of the undisturbed mucosa surrounding the lesion but also in the cells that were spreading in a single or double layer over the floor of the ulcer. When a similar lesion was made in the gall bladder[2], a very striking increase in proliferative activity was noted in the columnar epithelium within twenty-four hours of operation. Again, nuclei in all phases of the mitotic cycle were found in the spreading cells, as well as in the epithelium at and near the ulcer margins.

Migration of the stratified epithelial cells in the urinary bladder may be responsible for the epithelialization of the defect, and mitosis may be concerned only with increasing the number of layers of cells. However, in the simple epithelium of the gall bladder, it is difficult to maintain that mitosis in spreading cells is not playing some part in covering the lesion. Both types of epithelia display a very early onset of increased proliferative activity, which would appear to be well established before the cells can be said to be firmly attached to the underlying tissues. In a study of the regeneration of tracheal epithelium in the rat, Wilhelm[3] also found some evidence of mitosis in migrating cells.

These findings are clearly at variance with current concepts of epithelial activity during wound healing. It is to be noted that the majority of investigations on wound healing have been carried out on skin and cornea, and generalizations derived from these two tissues may be misleading when applied to others that have received less attention.

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[1] McMinn, R. M. H., and Johnson, F. R., *Brit. J. Surg.*, **43**, 99 (1955).
[2] McMinn, R. M. H., and Johnson, F. R., *Brit. J. Surg.* (In the press).
[3] Wilhelm, D. L., *J. Path. Bact.*, **65**, 543 (1953).

The Juvenile Hormone of Insects

Since the pioneering researches of Wigglesworth[1] the corpora allata have been known as the source of a 'juvenile hormone' which opposes or prevents the metamorphosis of immature insects. The presence of this hormone exerts a biochemical restraint on the cellular transformations responsible for the metamorphosis of the insect as a whole. These facts have been ascertained by biological procedures such as parabiosis and the transplantation of living corpora allata[2]. The hormone itself has apparently not been extracted or obtained apart from the living insect or endocrine organ.

Studies of the Cecropia silkworm (*Platysamia cecropia* L.) have recently revealed a rich depot of the corpus allatum hormone in the abdomen of the adult male of this moth. By the extraction of abdomens with organic solvents it has been possible to prepare the first potent extracts of the juvenile hormone. The latter, when injected into previously chilled pupæ of *Platysamia cecropia* or *Telea polyphemus*, duplicate the results obtained by the implantation of living, active corpora allata; that is, the formation of the adult moth is blocked and the pupa is forced to transform into a second pupa. The hormonal extracts from Cecropia have also been found active when tested on *Pieris brassicae* (Lepidoptera), *Tenebrio molitor* (Coleoptera), *Rhodnius prolixus* (Hemiptera) and *Periplaneta americana* (Blattaria).

The hormone is readily extracted when one or more adult male abdomens are blended at room temperature with ether, petroleum ether, ethanol or methanol. Ether appears to be the solvent of choice. After evaporation of the solvent in a water bath, the hormone is recovered as a residual, golden-yellow, non-toxic oil of low viscosity. Each abdomen yields approximately 0·2 ml. of the active oil, and it is therefore possible to obtain a manageable volume of extract from even a single abdomen. When injected into Polyphemus pupæ weighing 5 gm., 0·025 ml. of the oil gives a clear-cut effect.

The hormone is insoluble in distilled water, and at all stages in extraction can be washed repeatedly with water without loss of activity. The hormone resists extraction when fresh abdomens are blended at room temperature with acetone, chloroform, benzene or carbon tetrachloride; but after initial extraction with ether, the hormone is soluble in acetone.

In addition to the above-mentioned solubilities, preliminary studies show that the hormone is a heat-stable substance which, at room temperature, is resistant to aqueous alkali (5 *N*), acid (0·2 *N*), and anionic and cationic exchange resins.

Only a trace of hormone is extractable from the heads and thoraces of male Cecropia moths, even though the corpora allata are located in the head. Evidently, little hormone is present at any one time in the corpora allata or the blood. But the hormone is easily eluted from any of a number of tissues in the abdomen of the male moth. The abdomen and its contents apparently act to extract the hormone continuously when the latter is secreted in the adult moth and during the final week of adult development. If one excises the corpora allata before this period, then no hormone is recovered later on from the abdomen. For reasons which are not understood, it has been impossible to extract any hormone from the abdomens of female Cecropia moths or from any part of male or female Polyphemus moths.

Endocrine studies making use of the extract have already revealed that the hormone is inactive when injected into isolated pupal abdomens or into other preparations where the prothoracic gland hormone is absent. The juvenile hormone intervenes in reactions to the prothoracic gland hormone which occur early in adult development, that is, during the first few days of the twenty-one days required for adult development at 25° C. It has no effect when injected after the fourth day. In the experiments performed thus far on silkworm pupæ, even the highest doses of hormone have failed to cause the reappearance of any trace of larval characteristics.

Extracts prepared from petroleum ether have been found active when applied topically to the outside of the pupal cuticle. The result is an insect which is a mixture of pupa and adult. Individuals of this type show a low viability and soon die without completing their development. Therefore, in addition to the theoretical interest of the juvenile hormone, it seems likely that the hormone, when identified and synthesized, will prove to be an effective insecticide. This prospect is worthy of attention because insects can scarcely evolve a resistance to their own hormone.

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A Humoral Stimulus to the Secretion of the Brain-Hormone in Lepidoptera

IN insects, growth and moulting depend on the activity of a number of endocrine organs. It is known that a group of neurosecretory cells in the brain secrete a hormone which induces the thoracic glands to produce another hormone, and that this second hormone probably stimulates growth of the body through yet other links[1]. However, the processes which precede and control the initial secretory activity in the brain are still largely unknown. Lees[2] has set out evidence in favour of the theory that secretion of the brain hormone is induced by nervous stimuli. On the other hand, Andrewartha[3] thought that the brain might respond to a humoral stimulus linked with nutrition.

The results reported here of some experiments done with the vine-moth *Phalaenoides glycine* Lew. (Noctuidae) do not seem to fit into Lees's theory. This insect over-winters as a diapausing pupa, but may have several non-diapausing generations during summer. At 25° C. in non-diapausing pupæ the brain did not appear to secrete the hormone necessary for adult development until 3–7 days after pupation. Removal of the brain before this critical period produced 'permanent' pupæ which survived for up to ten months. Unoperated control pupæ became adult in about three weeks.

'Permanent' pupæ were prepared by removing their brains less than 24 hr. after pupation. They were divided into two groups. In one group each of the pupæ received one or two brains from larvæ of *P. glycine* which had spent less than 24 hr. in the final instar and had not eaten any food since the previous instar. The larval brains were implanted immediately after the host's brain had been removed. In the other group of pupæ nothing was implanted. It seems safe to assume that the larval brains implanted in this experiment had not been stimulated before the operation, because they had just completed a secretory cycle and previous observations had shown that final instar larvæ needed at least eight days of 'obligatory' feeding to induce pupation. Seven out of twenty-four of the pupæ with implanted brains became adult within 40 days. Of twenty-two brainless controls, none became adult.

This suggests that in *P. glycine* the stimulus to the brain is humoral rather than neural. The possibility

of stimulus through stray regenerating nerve fibres cannot be ruled out; but it seems unlikely. The condition of the pupal body which induced neurosecretion was not transient but persisted for at least seven months. This was shown by implanting young larval brains into 'permanent' pupæ at ten days, four months and seven months after pupation. One or more in each class became adult.

Williams[4] implanted the brains of young larvæ of *Platysamia cecropia* into brainless diapausing pupæ and obtained some adult moths. He gave no information on the period of 'obligatory' feeding; but it is probable that these brains had not been stimulated by their own bodies and that his positive results are also explicable in terms of a humoral stimulus. The evidence presented in this communication suggests that in some insects humoral factors alone may be sufficient to stimulate the cerebral neurosecretory cells. In *Rhodnius prolixus* and *Bombyx mori*[3] the central nervous system appears to play an essential part; but it is possible that even in these species nervous control is superimposed on a humoral mechanism.

Thanks are due to Dr. H. G. Andrewartha of this Department for advice, guidance and criticism. This work was carried out during the tenure of a studentship of the Commonwealth Scientific and Industrial Research Organization and of a grant of the University of Adelaide.

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[1] Wigglesworth, V. B., "The Physiology of Insect Metamorphosis" (Cambridge Univ. Press, Cambridge, 1954).
[2] Lees, A. D., "The Physiology of Diapause in Arthropods", pp. 112 and 116 (Cambridge Univ. Press, Cambridge, 1955).
[3] Andrewartha, H. G., *Biol. Rev.*, **27**, 50 (1952).
[4] Williams, C. M., *Biol. Bull.*, Woods Hole, **103**, 120 (1952).

Production of Human Antiglobulin Reagent in Sheep

The human antiglobulin reagent described by Coombs, Mourant and Race[1] was prepared in rabbits. Later, Eyquem (personal communication), Hill and Haberman[2] and Dunsford (personal communication) produced reagents in goats, and Eyquem (personal communication) in donkeys. I have tried to produce a reagent in a variety of animals, including rabbits, hens, sheep and the horse. Rabbits, of course, have been used in many laboratories; but it seemed it would be an advantage if an animal could be used from which more serum was available when immunization was satisfactorily completed. Sheep were found to be satisfactory animals.

Intramuscular injections of alum-precipitated serum were given and the animals bled at various intervals. The sheep serum was tested as an absorbed and as an unabsorbed diluted reagent against cells sensitized with the incomplete forms of anti-*D*, anti-*K*, anti-Fy^a, anti-*A*, anti-Jk^a and anti-Le^a. Direct tests were also carried out with cells from cases of acquired hæmolytic anæmia and with cells obtained from the cord blood of babies affected with hæmolytic disease of the newborn.

These results were compared with those obtained when standard antisera prepared in rabbits were used, and the results were very satisfactory. Strong positive results were given using the sheep antiglobulin serum. When the absorbed serum was used, if weakly sensitized cells were used as test cells, zoning was detected.

Many examples of each of the antisera listed above were used in the tests, and the appropriate antibodies were readily detected, the most difficult being anti-Le^a and anti-Jk^a. These antibodies require to be freshly collected or to have suitably selected normal fresh serum added to them to give optimum reactions. Certain examples of this antibody series do require a more concentrated antiglobulin reagent than that which is normally used in routine work. Crawford, Cutbush and Mollison[3] consider that anti-Le^a antibodies are of the alpha- and beta-globulin type and that this is the reason why a more concentrated antiglobulin reagent is required. It seems probable that some examples of anti-Jk^a antibodies fall into this class.

These difficulties, of course, are not confined to sheep antiglobulin reagents, but occur with reagents prepared in other animals. More information is required about the action of anti-Le^a and anti-Jk^a and the best methods for their detection and use.

The reagent was tested for avidity, for freedom from false positive results and for efficacy in routine use. In all these tests it was as good as many reagents prepared in rabbits, with which it was compared, and especially noteworthy was its freedom from false positive results.

Full details will be published elsewhere. I wish to thank the Evans Biological Institute, Runcorn, for providing the sheep for injection.

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[1] Coombs, R. R. A., Mourant, A. E., and Race, R. R., *Lancet*, **ii**, 15 (1945).
[2] Hill, S., and Haberman, J. M., *Amer. J. Clin. Path.*, **24**, 305 (1954).
[3] Crawford, H., Cutbush, M., and Mollison, P. L., *Brit. J. Hæm.*, **1**, 410 (1955).

Cytoplasmic Inheritance

From the point of view of cell physiology we can distinguish two distinct levels of gene action. One level is that at which the synthesis of macromolecules is controlled. The second level is that of the organization of macromolecules into physiological units. In differentiated cells it seems probable that the synthesis of macromolecules is normally under rather direct control of Mendelian (chromosome) genes, whereas their organization into functional units is often largely controlled by cytoplasmic inheritance (for reviews, see Lwoff[1], Ephrussi[2], Michaelis[3] and Danielli, Lorch, Ord and Wilson[4]).

Many authors speak simply of cytoplasmic inheritance, without inquiry into its mechanism. Others refer cytoplasmic inheritance to plasmagenes. The use of the term 'plasmagene' necessarily involves associations with chromosome genes; this is undesirable, since the determinants of cytoplasmic inheritance usually differ in their nature and function from chromosome genes. I wish therefore to suggest that a new term should be used for those determinants of inheritance which are themselves organizations of molecules or of processes, and are self-reproducing. Such determinants include centrosomes, chloroplasts, kinetosomes, kinetoplasts and the cytochrome oxidase-containing granules of yeasts. Many such cytoplasmic bodies differ from chromosome genes in

containing no deoxypentose nucleic acid, and in having no function of controlling the synthesis of macromolecules. On the other hand, they are self-reproducing, do not arise spontaneously, and control (and may perform) at least one cellular function. They are in fact the homeostatic units responsible for controlling those activities of a cell which are functions of organizations of macromolecules. They are thus self-reproducing homeostatic units, the specific properties of which can only be defined at the level of organizations of macromolecules. I wish, therefore, to suggest, as a first attempt at finding a suitable term for these determinants, the word *homeostat*. A homeostat may be defined as an organization of macromolecules, or of processes, which is self-reproducing and which may also (and usually does) determine and control the expression of one or more characters in a cell lineage.

To illustrate a major possible usage for such a term, we may refer to differentiation. Then differentiation may be regarded as the development of a variety of homeostats which are the characteristic determinants of different cell lineages, against the constant background of Mendelian genes carried by the chromosomes. All cell lineages in one animal normally carry the same chromosome genes, and each cell lineage carries a distinct set of homeostats.

By using quite different terms for genes and for homeostats, it becomes much easier to think of them independently, and to avoid unjustified and unnecessarily limiting associations.

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[1] Lwoff, A., "Problems of Morphogenesis in Ciliates" (Wiley, New York, 1954).
[2] Ephrussi, B., "Nucleo-cytoplasmic Relations in Micro-organisms" (Clarendon Press, Oxford, 1953).
[3] Michaelis, P., "Adv. Genet.", **6**, 288 (1954).
[4] Danielli, J. F., Lorch, I. J., Ord, M., and Wilson, E., *Nature*, **176**, 1114 (1955).

Diurnal Rhythms of Activity in Terrestrial Arthropods

Attention has recently been directed to the close parallel that exists between the rhythm of biting activity in certain East African mosquitoes and the bimodal flight activity of the Trichoptera, and it is suggested that in insects showing abrupt 'eo-crepuscular' activity the control is mainly microclimatic[1]. If this is so, the diurnal rhythm must be largely 'exogenous' in nature and would not persist under constant environmental conditions as 'endogenous' rhythms do. The majority of animal species, however, show a combination of both types, and such periodicity is designated 'composite'. This type of rhythm occurs in cockroaches and has recently been shown to have a neurosecretory basis[2].

Even innate endogenous rhythms are regulated by changes in environmental factors such as light, temperature and humidity; but as they are not a direct response to them, such factors have been referred to by me as 'clues', a term which appears to correspond with the German 'Zeitgeber', and their importance lies in the maintenance of rhythm and in keeping it in phase with the environment[3]. Under natural conditions there are probably several 'clues' active at the same time, one of which is generally the ruling factor of an animal's periodicity. In most cases light intensity is the factor that sets its mark on activity as a whole, while others, such as temperature, humidity or wind, which may have even greater ecological importance, are, in the main, responsible for the degree of intensity. Thus in woodlice, although a composite diurnal locomotory rhythm is synchronized with the environment by alternating light and darkness[4], the intensity of nocturnalism in different species is correlated with the ability to withstand water-loss by transpiration[5].

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[1] Haddow, A. J., *Nature*, **177**, 531 (1956).
[2] Harker, J., *J. Exp. Biol.*, **33**, 224 (1956).
[3] Cloudsley-Thompson, J. L., *Acta Med. Scand. Supp.* (in the press); *J. Linn. Soc. (Zool.)* (in the press).
[4] Cloudsley-Thompson, J. L., *J. Exp. Biol.*, **29**, 285 (1952).
[5] Cloudsley-Thompson, J. L., *J. Exp. Biol.* (in the press).

A Filamentous Saprophyte from Wookey Hole Caves

An unusual branched filamentous organism, superficially resembling a water mould, was found growing submerged in complete darkness, by Dr. R. E. Davies, in the ninth cavern of Wookey Hole, near Wells, Somerset, on December 11, 1955. The plant was attached to the insulation of a reel of cable deposited in the caves on June 28, 1953, under about 10 ft. of water.

The felt consisted of a tangled mass of large septate, branching filaments (10–30μ in diameter), many of which were coated with ferric hydroxide in the form of strands (Fig. 1) Branches arise just beneath the cross-walls as in *Cladophora*, and taper to fine septate threads (*c.* 4–7μ across). There was no evidence of pigmentation or of the presence of chromatophores either in the original material or in the organism after culture in daylight for more than three months. The cytoplasm contains minute granules and the cells of the older filaments are extensively vacuolated (Fig. 2). The presence of nuclei has not been established although material has been stained with acetocarmine, hæmatoxylin and by the Feulgen technique. Treatment of the cell wall with chlor-zinc-iodide did not give the typical cellulose reaction, a yellow-brown coloration resulting. Septate hyphal-like threads emerge from broken ends of the filaments, and, when cells of the large filaments die, the protoplasts of the adjacent cells often grow through into the empty cells (Fig. 3), where they may fuse with one another. Cross-connexions may develop between young filaments. No reproductive structures have been seen. Pure cultures of the organism have been obtained on potato extract agar, and the original material has been also maintained in liquid inorganic media.

Only one previous record of an apparently algal saprophytic organism of a branching filamentous type (*Saprochaete saccharophila* Coker and Shanor[1]) is known to us. The specimen from Wookey Hole differs from *Saprochaete* in a number of morphological features and, among the algae, resembles members of the Cladophorales rather than of the Chætophorales. The nutrition and certain morphological characters seem to indicate fungal affinities; but the very large cell size is uncommon in fungi. Attempts are now

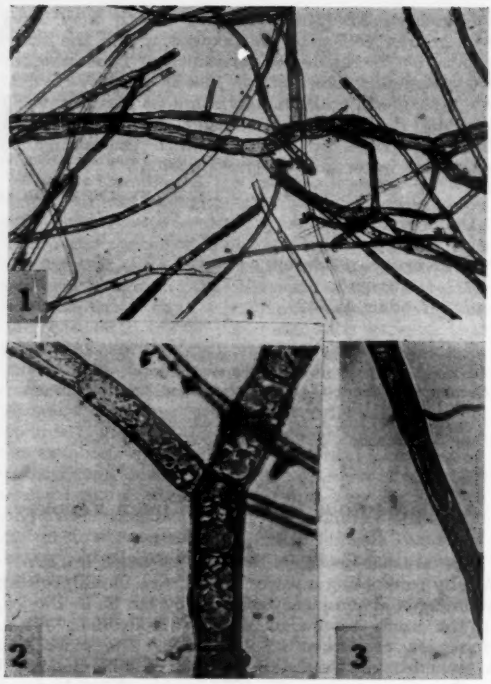

Fig. 1. Photomicrograph showing the range of size of the filaments, the mode of branching and a strand-like coating of ferric hydroxide on the largest filament. (× 90.) (2) The cells contain conspicuous rounded vacuoles and minute granules. (× 360.) (3) The peg-like ingrowth from one cell into the adjacent cell is clear. (× 360)

being made to culture the organism on various media in the hope that further investigation will throw light on the metabolism and systematic position of this interesting plant.

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[1] Coker, W. C., and Shanor, L., *J. Elisha Mitchell Sci. Soc.*, **55**, 152 (1939).

Occurrence of Apiose in *Hevea brasiliensis*

Fructose, glucose, quebrachitol, mesoinositol, and (−)-inositol have been detected in the free state in *Hevea* latex serum, and glucose, galactose, mesoinositol, and an unknown sugar (probably a ketose) were obtained on hydrolysis of a latex lipid fraction[1]. The work reported here is an examination of *Hevea* bark tissues for reducing sugars, and, in view of the common 5-carbon branched skeleton unit of the isoprenoid compounds, particular interest lay in the detection of branched-chain sugars.

The plant material used was whole bark, which had been collected fresh and dried at 90°. A powdered sample (50 gm.) was boiled under reflux for 4 hr. with 0·2 *N* sulphuric acid (500 ml.) and filtered. After saturating the filtrate with barium carbonate, and filtering, the solution was concentrated under reduced pressure to a syrupy residue. This was extracted with boiling 95 per cent ethanol (100 ml.), and the insoluble material removed on the centrifuge. The ethanol was distilled off, and the resulting syrup boiled for 5 min. with water (50 ml.) and animal charcoal (2 gm.) and filtered. After concentration, and extraction with boiling ethanol, as before, the solution was finally concentrated to a thick syrup.

Chromatography of this product was carried out on Whatman No. 1 paper with a solvent system of *n*-butanol–water–ethanol (50 : 40 : 10 by vol.) in runs of up to 55-hr. duration. Eight compact and fully separated spots were stained by silver nitrate reagent. The fastest-moving component (R_F 0·28) was of greatest interest, since this agreed exactly with an authentic specimen of apiose prepared by hydrolysis[2] of parsley apiin (Merck). By the use of specific spray reagents, and variation of solvent system in one- and two-dimensional runs with comparative mixtures of known compounds, it was concluded that the remaining spots were due to maltose, galactose, glucose, fructose, quebrachitol, mesoinositol, and possibly xylose. Only glucose, fructose and quebrachitol could be detected in water extracts of bark. In order to characterize further the substance resembling apiose, a preparative fractionation of the sugar mixture was carried out on a column of cellulose powder[3]. The authentic apiose, which contained about 5 per cent glucose impurity, was fractionated in the same way. A fraction (I) isolated from the bark mixture yielded 11 mgm. of syrup. This was indistinguishable from apiose when chromatographed separately and in mixtures in a wide range of solvents. With high concentrations of fraction I a faint spot, stained red by aniline hydrogen phthalate, was visible immediately behind, but completely separated from, the suspect apiose spot. Apiose, while not yielding furfuraldehyde when treated with acid, did give faint colours (yellow-brown) when sprayed with aniline hydrogen phthalate or *p*-anisidine hydrochloride. Identical colours were given with the corresponding component of fraction I.

Phenylosazones were prepared from fraction I and apiose, and recrystallized from aqueous ethanol. These melted at 154°–156°, and the mixed melting point was unchanged. Thus, it was concluded that the main component of fraction I was apiose.

This sugar has the same carbon structure as the skeleton unit of isoprenoid substances, and it has been suggested[4] that apiose could give rise to simple terpenes by condensation and reduction. Such a reaction seems unlikely, but the presence of apiose in *Hevea* does suggest a possible metabolic link between the sugars and the 5-carbon intermediates of isoprenoid synthesis. An interesting connexion was noted between parsley, from which apiose is most readily obtained, and several rubber-producing plants. The carbon tetrachloride extracts of *Hevea* bark, *Taraxacum kok-saghyz* root and *Taraxacum officinalis* root, were saponified, and extracted with ether. After removal of ether each of these extracts possessed the odour characteristic of fresh parsley.

I am indebted to the Dunlop Rubber Co., Ltd., for permission to publish this note.

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[1] Smith, R. H., *Biochem. J.*, **57**, 140 (1954).
[2] Vongerichten, E., *Ann.*, **321**, 74 (1902).
[3] Hough, L., Jones, J. K. N., and Wadman, W. H., *J. Chem. Soc.*, 2511 (1949).
[4] Stewart, A. W., in "Recent Advances in Organic Chemistry", 4th edit., 270 (Longmans, Green and Co., London, 1920).

Association of a Species of *Itersonilia* with Parsnip Canker in Great Britain

A SPECIES of *Itersonilia* Derx was isolated by Wilkinson[1] in 1952 from cankers on parsnip roots in the United States. He did not publish a species identification, nor did Sowell[2] in a later note on the fungus; but cultures were afterwards lodged by Sowell at the Centraalbureau voor Schimmelcultures, Baarn, under the name *I. perplexans*. Wilkinson demonstrated the pathogenicity of the fungus and showed that it was also responsible for lesions on the leaves. I have made similar observations in Britain.

The fungus was first obtained, with five others, in the autumn of 1954, from tissue taken from the inner margins of parsnip canker lesions. Isolations were made by surface sterilizing, washing and planting small pieces of infected tissue on prune agar. During the winter of 1955–56, several isolates of each of these fungi were tested in the laboratory for pathogenicity to parsnip roots. Of the six fungi tested, only one was found to infect both wounded and unwounded parsnip tissue and this fungus was identified as a species of *Itersonilia* Derx. The Commonwealth Mycological Institute confirmed this identification and reported that in many respects the fungus resembled *I. perplexans*.

During the winter and spring of 1955–56, further isolations were made from cankerous lesions by the spore-dropping technique used by Wilkinson[1]. Pieces of diseased tissue were attached to the lid of a Petri dish with 'Bostik' and suspended over a plate of prune or Waksman's egg albumen agar[3]. When incubated at 21° C., colonies of *Itersonilia* frequently developed on the agar from ballistospores ejected from the pieces of diseased material. Inoculation of parsnip roots in the laboratory with several of these cultures resulted in rotting, similar to that produced by the 1954 isolates, and re-isolation by the spore-dropping technique from the artificial lesions established the pathogenicity of the fungus.

Itersonilia has been obtained from two types of lesion both of which are quite common in the field. The first type was dark brown to black in colour and extended 2–3 mm. into the tissue of the shoulder. Where the surface tissues were ruptured, the underlying parenchyma usually appeared slightly purplish. In the second type the surface of the root was invariably ruptured. The exposed parenchymatous tissue was light brown to orange-brown in colour, but frequently included areas which were darker brown and rotted. When inoculated into parsnips, the fungus produced lesions only of the first type. Thus although it was clearly the cause of this type of lesion, the significance of its association with the other type remains to be determined.

The fungus has been obtained from parsnips grown at the National Vegetable Research Station and at two farms in Buckinghamshire and one in Kent.

Leaf infection of young plants has been demonstrated by single or successive sprayings of a macerated mycelial suspension on to the foliage of potted parsnips in the glasshouse. The lesions developed within six days and appeared as silvery green patches approximately 1 mm. diameter or as larger patches, each consisting of a necrotic centre surrounded by a light-green halo. The re-isolation of *Itersonilia* from the lesions by the spore-dropping technique confirmed that the lesions were caused by the fungus.

The present work fully supports that of Wilkinson and indicates that a fungal pathogen hitherto unreported in Great Britain is associated with parsnip cankers in Britain. Its occurrence is apparently widespread; but further work will be necessary before it can be determined whether *Itersonilia* is responsible for most, or only part, of the somewhat variable symptoms on parsnips at present grouped under the term 'canker'.

Thanks are due to Dr. M. B. Ellis, of the Commonwealth Mycological Institute, for the identification of the culture of *Itersonilia*.

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[1] Wilkinson, R. E., *Phytopath.*, **42**, 23 (1952).
[2] Sowell, G., *Phytopath.*, **43**, 485 (1953).
[3] Waksman, S. A., *Soil Sci.*, **8**, 71 (1919).

Control of Coffee Berry Disease in Kenya

A DISEASE of coffee berries, attributed to a form of *Colletotrichum coffeanum* Noack, was first described from West Rift areas of Kenya in 1922 [1]. It caused extensive losses and the abandonment of coffee cultivation on many estates, and although by 1939 selections of coffee which showed some degree of resistance had been made, direct attack with a considerable range of fungicides had led to little, if any, control of the disease. A detailed account of the disease and of investigations up to 1950 has been published[2].

Previous work[1] had shown that disease symptoms could be reproduced by the inoculation of the pathogen into wounded or detached berries; but the degree of pathogenicity was not established until symptoms were produced using spore inoculum without wounding[3].

In 1951, the disease appeared for the first time in the East Rift coffee area, the higher-altitude zones being affected. As this area produces the greater proportion of the Kenya coffee crop, investigations on the disease received a considerable impetus. Further fungicide trials were carried out using 'Perenox', phenyl mercury, 'Fixtan', 'Tulisan' and calcium sulphamate; but no degree of control was observed.

Early in 1955, the effects of a wide range of fungicides were tested on an estate in the East Rift area. Fifteen treatments were compared using six replications of a balanced, incomplete block design with three plots per block. Each block consisted of one head of three multiple-stem trees, the trees selected having three equal heads each. In this way, individual tree variations in susceptibility and yield could be statistically controlled. The following fungicides were applied at monthly intervals during the long rains (March–May) and the short rains (November–December), giving a total of five applications; 'Perenox', 'Karathane', 'Verdasan', 'Fermate', 'Zerlate', 'Dithane', 'Actidione', 'Captan', 'Glyoxalidine' and calcium sulphamate. In addition, 'Perenox' was applied at fourteen-day intervals throughout the season.

Only 'Perenox', applied at fortnightly intervals, and 'Verdasan' gave an effective control of the disease. No control could be detected when 'Perenox' was applied at the same frequency as 'Verdasan'. As

fortnightly fungicidal application is undesirable, 'Verdasan' affords the best possibility of control as yet. In view of the earlier failure to obtain direct control of the disease with fungicides, the importance of these results is considerable.

Repeated calcium sulphamate treatments at 1, 3 and 6 per cent were all found to be highly phytotoxic although previously a single application at 1 per cent had not produced any adverse effects.

A laboratory technique for testing fungicides on detached berries has given results comparable with those of the field trials. Preliminary tests using 'Griseofulvin' at a concentration of 880 p.p.m. have given results similar to 'Verdasan'.

Further field trials are in progress.

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March 14.

[1] McDonald, J., *Trans. Brit. Mycol. Soc.*, **2**, 145 (1926).
[2] Rayner, R. W., *East African Agric. J.*, **17**, 130 (1952).
[3] Rayner, R. W., Ann. Rep. Dept. Agric. Kenya, Pt. 2 (Invest.) (1952).

Suppression of the Sprouting of Potatoes by the Vapour of Alcohols

The use of a growth-inhibiting vapour for the commercial suppression of the sprouting of potatoes offers certain advantages over the employment of suppressant dusts, though these have been used with success. In particular, application of the treatment can be delayed until signs of sprouting are observed —which in some years, when the onset of sprouting is late, can lead to an appreciable saving in cost— and the farmer need not decide whether or not to employ a sprout suppressant until some time after harvest, when he may be in a better position to know whether it is likely to be advantageous to store his potatoes late. Attempts have therefore been made to use a number of gases and vapours, as, for example, ethylene[1].

The fact that the volatile metabolic products of potato tubers will completely inhibit their sprouting, if allowed to accumulate in the absence of carbon dioxide, led to the discovery that the vapour of *n*-amyl alcohol was a very effective sprout inhibitor[2]. Ethyl alcohol vapour had previously been described as retarding sprout growth[3]. Later, the vapours of both *iso*-amyl and active amyl alcohol were found to be effective at concentrations of about 1 mgm./l., and commercial amyl alcohol (a variable mixture of the *iso* and active alcohols) was used successfully on the sixteen-ton scale[4]. It seemed possible that alcohol vapours in general might retard sprout growth, and the results of a number of tests, given in the accompanying table, seem to confirm this. In most cases no attempt has been made to extend the tests to cover a number of concentrations, although this has been done to a limited extent with nonyl alcohol, which has shown promise of being applicable on a commercial scale[5].

Mr. R. J. Gibbs helped with the work described here. It was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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[1] Barker, J., Rep. Food Invest. Board, Lond., for 1933, 80 (1934). Furlong, C. R., *Agric. J. Min. Agric.*, **55**, 81 (1948).
[2] Burton, W. G., *New Phytol.*, **51**, 154 (1952).
[3] Huelin, F. E., Rep. Food Invest. Board, Lond., for 1932, 51 (1933).
[4] Burton, W. G., *Annexe* 1954–1 *au Bull. de l'Inst. Intern. du Froid*, 81 (1954).
[5] Burton, W. G., *The Grower*, **45**, 1368 (1956).

Carbon Dioxide Injury and the Presence of Succinic Acid in Apples

Recent work in this Laboratory[1] has shown that succinic acid may not only inhibit oxidative processes, as shown by earlier workers[2], but also it may be actually toxic to plant material. Succinate supplied to respiring disks of apple peel (in a suitable buffer system at *p*H 4·1) at concentrations greater than about 0·025 *M* reduces oxygen uptake and carbon dioxide output, and in a comparatively short time the respiration falls practically to zero and the tissue becomes brown and 'dead'. At this external concentration of succinate the internal concentration is less than 0·001 *M*.

In normal healthy apples we have found succinic acid only occasionally and in trace amounts in either the peel or the pulp. This does not necessarily mean

Table 1. Suppression of the Sprouting of Potatoes by Alcohol Vapours

Variety of potato	Alcohol	Conc. (mgm./l.)	Temp. °C.	Duration of expt. (days)	Wt. of sprouts as per cent total wt.	Wt. of sprouts on control as per cent total wt.	Sprouting on treated tubers as per cent that on control (approx.)
Dr. McIntosh	Methyl	18·3	10	68	0·19	0·36	53
Dr. McIntosh	Ethyl	15·1	10	84	0·0	0·76	0
Dr. McIntosh	*iso*-Propyl	8·9	10	84	0·0	0·76	0
Majestic	*n*-Butyl	5·4	10	55	0·02	1·64	1
Majestic	*n*-Amyl	1·5	10	34	0·0	1·05	0
Dr. McIntosh	*n*-Amyl	1·9	10	84	0·0	0·76	0
Dr. McIntosh	*tert.*-Amyl	9·0	10	84	0·0	0·76	0
Majestic	*tert.*-Amyl	0·6	10	51	0·0	1·07	0
Majestic	*n*-Hexyl	2·3	10	55	0·67	1·64	41
Majestic	*sec.*-Heptyl	2·6	10	55	0·0	1·64	0
Majestic	Octyl*	1·3	10	55	0·47	1·64	29
Majestic	Nonyl†	4·8	10	63	0·0	6·81	0
Stormont Dawn	Nonyl	3·7	10	91	0·0	3·85	0
Dr. McIntosh	Nonyl	0·2	10	172	0·0	5·02	0
Dr. McIntosh	Nonyl	0·02	10	109	0·07	2·02	4
Dr. McIntosh	Nonyl	0·06	20	54	4·35	6·74	65
Dr. McIntosh	Nonyl	0·07	20	17	2·74	2·73	100
Dr. McIntosh	Nonyl	0·31	20	21	0·0	2·88	0
Dr. McIntosh	Nonyl	0·87	20	22	0·0	3·50	0
Majestic	*n*-Decyl	1·6	10	55	0·14	1·64	9

* 2-ethyl-hexan-1-ol † 3-5-5-trimethyl-hexan-1-ol

Table 1. THE QUINIC, SUCCINIC AND MALIC ACID CONTENT OF THE PULP OF APPLES STORED UNDER VARIOUS ENVIRONMENTAL CONDITIONS

Treatment	Temp.	Days	Quinic (mgm./100 gm. fresh wt.)	Succinic (mgm./100 gm. fresh wt.)	Malic (mgm./100 gm. fresh wt.)	Condition of tissue
Air	37° F.	31	84·0	—	1,221·7	No damage
10 per cent CO_2	37° F.	31	87·5	6·35	1,228·5	No damage
20 per cent CO_2	37° F.	11	89·5	21·0	1,224·5	CO_2 damage
Air	50° F.	90	84·0	Trace	907·8	No damage
20 per cent CO_2	50° F.	90	96·3	1·10	879·5	No damage

that succinate is not a normal intermediate metabolite in the fruit; its turnover-rate may be so high as to prevent accumulation. It was noticed, however, that on paper chromatograms of the acid fractions from apples suffering from incipient carbon dioxide injury (a physiological disease of fruit stored in hypernormal concentrations of carbon dioxide, and resulting in the death of the affected tissue), there appeared a spot corresponding in position to that of succinic acid. A sample of the acid giving this spot was isolated from an extract of 1 kgm. of affected fruit and it proved to be a dibasic acid having an analysis of: C, 40·6; H, 5·3; O_2 (by difference) 54·1 (succinic acid = C, 40·7; H, 5·1). It melted at 185° C., and when mixed with authentic succinic acid produced no lowering of the melting point. The *p*-nitrobenzyl ester had a melting point of 87·5° C. A similar derivative from authentic succinic acid had a melting point of 88·0° C.

Determinations of the amount of the various organic acids present in fruit stored in air and in various concentrations of carbon dioxide at 3° C. and 10° C. (apples are more susceptible to carbon dioxide injury at lower, than at higher, temperatures) were made and the extent of carbon dioxide injury in affected fruit was recorded. The results are given in Table 1.

These results show that carbon dioxide injury is accompanied by an increase in succinic acid in the tissue. It appears that an abnormality of metabolism is induced in the tissue by hypernormal concentrations of carbon dioxide in the surrounding atmosphere which results in an accumulation of succinic acid. This, in turn, it is suggested, kills the tissue.

Further details of this work and its wider implications will be presented elsewhere.

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[1] Hulme, A. C., and Neal, G. E. (in preparation).
[2] Turner, J. S., and Hanly, V. F., *New Phytol.*, **48**, 149 (1949).

Nitrogenous Reserves of Apple Trees

WHEN young apple trees assimilate nitrogen, reserve materials are generally laid down in the tissues of the stem and root[1]. Only part of these nitrogenous reserves can be extracted from the stem by exhaustive treatment with 70 per cent (v/v) aqueous ethanol, and a study has recently been made both of the nature of the reserves and of their extraction from the tissues by different solvents.

Amino-acids were separated chromatographically from the tissue extracts by a modification of the method of Moore and Stein[2,3], using ion-exchange resins 'Dowex 50' or 'Zeo-Karb 225'. In this way, arginine and asparagine were identified as the chief nitrogenous reserves; together, they represented 70–80 per cent of the total soluble nitrogen which could be extracted. Arginine alone accounted for more than 60 per cent of the soluble nitrogen in a typical analysis, and, although most of the amino-acids commonly found in plant tissues were present, none of them exceeded 1 per cent of the total soluble nitrogen.

It has also been shown that a large part of the arginine is bound in the tissue, so that it cannot be readily extracted with 70 per cent ethanol. Successive treatments of the finely divided tissue with hot or cold ethanol gave apparent completion of extraction, since the final extract yielded less than 1 per cent of the soluble nitrogen. Nevertheless, further treatment with hot water removed additional soluble nitrogen, amounting to 20–30 per cent of the total. The analyses, summarized in Table 1, indicated that large quantities of arginine were present in the water extract, despite the previous exhaustive treatment with ethanol.

Table 1. EXTRACTION OF APPLE STEM TISSUE WITH 70 PER CENT ETHANOL FOLLOWED BY WATER

	Total nitrogen in extract (per cent)	
	70 per cent ethanol	Water
Arginine	62·0	66·0
Asparagine	15·0	
Glutamic acid	1·0	
Serine	1·0	
Histidine	0·3	
γ-Amino-butyric acid	0·2	0·3–1·0
Alanine	0·2	
Valine	0·1	
Other α-amino-nitrogen	0·3	
Ammonia	0·8	0·6
Other soluble nitrogen	19·0	32·0

Although asparagine and some of the amino-acids were effectively extracted by aqueous ethanol, it is evident that this solvent should be used with caution for quantitative studies of the nitrogenous constituents of plants. In the present experiments, some direct evidence has been obtained that arginine, when added in ethanolic solution to apple stem tissue, is removed from solution, probably owing to reaction with acidic components. Hot water, or sodium chloride solution buffered at *p*H 7, as used by Danielsson[4], appears to be much more effective than aqueous ethanol for extracting the dialysable nitrogenous constituents, particularly when large reserves of arginine may be present, as in apple stems.

A full account of the investigation will be published elsewhere.

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[1] Oland, K., *Phys. Plant.*, **7**, 463 (1954).
[2] Moore, S., and Stein, W. H., *J. Biol. Chem.*, **192**, 663 (1951).
[3] Yemm, E. W., and Cocking, E. C., *Analyst*, **80**, 209 (1955).
[4] Danielsson, C. E., *Acta Chem. Scand.*, **5**, 541 (1951).

Interaction between Nickel and Calcium in Plants

In the course of an investigation into the toxic effects of nickel on plants, it was found that the calcium content of nickel-toxic oat plants was consistently higher than that of healthy plants[1]. The absorption of other major nutrients, on the other hand, was reduced in the presence of nickel. In contrast, tomato plants showed a reduced content of all major elements, including calcium, when supplied with nickel in toxic amounts. The toxicity symptoms produced in both plants consist of chlorosis (of young leaves) accompanied by longitudinal necrotic striping (oat) or necrotic areas of the older leaves (tomato). Growth is reduced and root development arrested; the roots become brown, with poor secondary-root production.

To investigate whether the effect of nickel on calcium absorption occurs external to the root, in the root, or in the plant, a split-root technique has been applied using oat and tomato in solution culture and radiocalcium (calcium-45) to identify the origin of the calcium afterwards found in the plant.

Four treatments were employed: (1) Whole root system in complete nutrient solution containing labelled calcium; (2) as for 1, with the addition of 2·5 p.p.m. nickel (as the sulphate); (3) root system divided between two compartments containing (*a*) complete nutrient solution and (*b*) complete nutrient solution with part of calcium as calcium-45; (4) as for 3, except that the (*b*) compartment contained 2·5 p.p.m. nickel.

Seedlings were raised in sand and transferred to the differential treatments, where growth was allowed to proceed for several weeks during which time mild symptoms of nickel toxicity appeared. Excessive reduction in growth due to nickel did not take place, although plants with split-roots were slightly smaller than those left undivided. At harvest, yields were recorded and plants divided into young and old leaves, petioles (tomato only), stems and roots. Major elements, iron and nickel, were determined in the dry matter. Calcium was precipitated as the oxalate for radioactive assay and the results used for calculating calcium absorbed after the start of the differential treatments, and further, to identify the calcium absorbed from the (*b*) compartments. Table 1 summarizes the main findings for young leaves.

For convenience, an increase in calcium content following the addition of nickel is hereafter referred to as positive calcium effect. Thus for oats, a positive calcium effect is found in both whole and split-root treatments, the magnitude of the effect being greater in the latter case. Tomatoes show a negative effect for plants with undivided roots and a positive effect where the roots were split. In comparing treatments 1 and 2, radioactive calcium analysis confirms this greater and lesser calcium uptake by oats and tomatoes respectively.

Table 1. Analysis of Young Leaves

		1 Whole root Healthy	2 Whole root Ni-toxic	3 Split root Healthy	4 Split root Ni-toxic
Ca (per cent in dry matter)	Oats	0·68	0·89	0·71	2·97
	Tomatoes	2·37	1·21	1·28	5·16
Per cent total Ca as ^{45}Ca labelled Ca	Oats	88·0*	95·0	69·0†	27·0
	Tomatoes	90·0	68·0	19·0	8·0
Ni (p.p.m. in dry matter)	Oats	—	60·0	—	49·0
	Tomatoes	—	106·0	—	25·0

* $\frac{\text{Ca absorbed after transfer}}{\text{Ca in seedling + Ca absorbed}}$

† $\frac{\text{Ca absorbed through } b \text{ roots only}}{\text{Ca in seedling + Ca absorbed through both sides of root system}}$

The relative uptake of calcium through the 'no-nickel' and the 'nickel' half-roots (*b*) can be deduced from a comparison of treatments 3 and 4. Compared with the earlier results for the nickel–calcium interaction, radioactive analysis yields the additional information that for both plants the greater part of the increased calcium content of the leaves was absorbed through the 'no-nickel' side of the root system. As would be expected, the nickel content of the leaves was reduced in the treatments in which nickel was supplied to only half the root system.

The injured appearance of nickel-toxic roots seems to provide a valid explanation for the reduced leaf content of major nutrients; but it is difficult to advance reasons for the increased calcium absorption by such roots, as occurs for oats in treatment 2. In the plants of treatment 4, however, the bulk of the calcium in the leaves has been absorbed through the undamaged part of the root system (although a positive calcium effect still holds for the nickel-toxic part of the root system).

The present results suggest that two opposing phenomena may be occurring simultaneously when nickel is absorbed by plants: (1) the roots are damaged and the absorption and translocation of all major nutrients are reduced; (2) nickel in the leaves, by some unknown mechanism, increases the absorption of calcium by the roots. Different plants may show these effects in differing degree; in oats (2) will be predominant, while in tomatoes (1) predominates until nickel reaches the top of a plant which has not had all its root system exposed to nickel.

Preliminary experiments on a range of about twenty common crop plants have shown the majority to have a zero or a negative calcium effect similar to tomato. Among the cereals, maize shows a positive effect while wheat and barley do not. Certain root crops, namely, red beet, sugar beet and swede turnips, show a positive effect to a marked degree. These plants show an extreme susceptibility to nickel toxicity[2]; but other highly susceptible plants such as sunflower do not show a positive calcium effect. Reversal of the calcium effect from negative to positive has also been shown for mustard, by the split-root technique.

Until now, nickel, in common with other heavy metals supplied in excess to plants, has been recognized to interfere in iron metabolism[3-6]; the tacit assumption being that nickel or other heavy metal replaces iron in some complex essential to normal nutrition. The results now obtained suggest how nickel may affect processes within the plant. It seems possible that organic acid metabolism may be affected in nickel-toxic plants and that the state of solubility of calcium in the tissues may be altered by increased production of oxalic acid, for example.

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Craigiebuckler, Aberdeen. April 5.

[1] Crooke, W. M., and Inkson, R. H. E., *Plant and Soil*, **6**, 1 (1955).
[2] Hunter, J. G., and Vergnano, O., *Ann. App. Biol.*, **39**, 279 (1952).
[3] Crooke, W. M., Hunter, J. G., and Vergnano, O., *Ann. App. Biol.*, **41**, 311 (1954).
[4] Crooke, W. M., *Ann. App. Biol.*, **43**, 465 (1955).
[5] Crooke, W. M., and Knight, A. H., *Ann. App. Biol.*, **43**, 454 (1955).
[6] DeKock, P. C., *Ann. Bot.*, **20**, 133 (1956).

A Model for manipulating Spirals

DARLINGTON[1] suggested that the coiling systems encountered in chromosomes are determined by spiral structures at the molecular level. Interest in the replication of spirals and in the separation in double spirals has been renewed recently[2-4] following proposals of helical structures for deoxyribonucleic acid[2] and for various proteins[5]. Some of the difficulties in the disentangling of twin spirals are simplified if the spirals are free to rotate about their axes, as may be demonstrated using the simple model here described.

The model consists of a stand holding parallel glass tubes which are free to rotate. In the model (Fig. 1) the stand is built of 'Meccano' parts and the three glass tubes are stoppered with rubber bungs into which small axles are inserted; they are linked together by a system of gears so that they all turn in the same direction at the same speed. Cotton tape is used for the spirals.

In the simplest manipulation, a single spiral wound about one rod, with its free end attached to an adjacent rod, is transferred to this rod when both are rotated. Other manipulations are based on this principle.

A double spiral on the centre rod, with free ends attached one to each of the side rods, is resolved into two single spirals by simple rotation, as shown in Fig. 1. If this process is thought to apply to structures of the Watson and Crick type, it would be necessary for new complementary chains to form simultaneously on the separating chains in order that two new helices be produced (Fig. 2*A*).

Two double spirals on a single rod can be separated one from another by a manipulation analogous to that shown in Fig. 1, or if the ends are appropriately arranged, they may be separated with exchange of partners as shown in Fig. 2*B*. With exchange of partners, double spirals of different constitution from the originals may be produced.

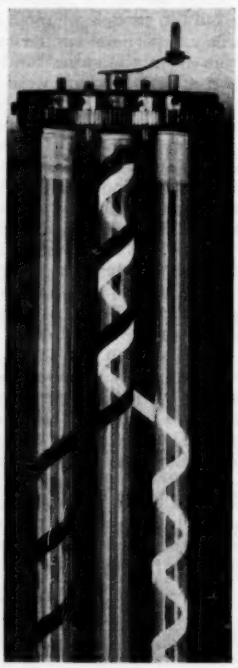

Fig. 1

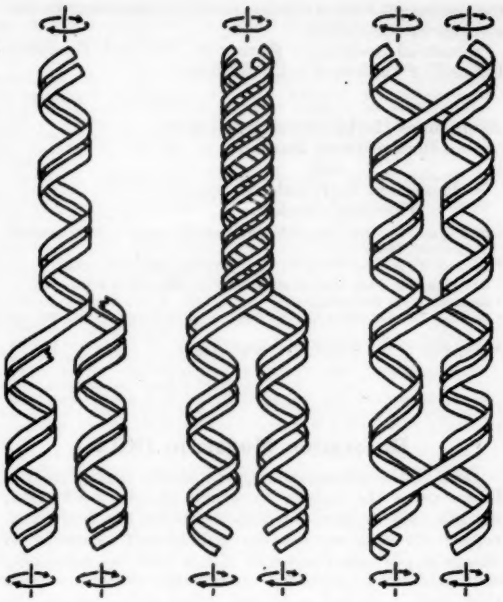

Fig. 2

Double spirals on adjacent rods may be made to change partners by simple rotation. Rotation may be interrupted and the free ends rearranged so that two or more exchanges can be effected (Fig. 2*C*). With the model it is possible to produce spiral systems resembling those postulated by Darlington[1] and others to account for crossing-over in chromosomes at meiosis. In Fig. 2*C*, where all possible exchanges between double spirals are shown, it may be seen that the pitch of the participating spirals must be varied slightly for this to occur. With non-flexible spirals, or with helices of the Watson and Crick type (formed of complementary chains), only certain exchanges are possible.

Continuous formation and separation of products from a template, as proposed by Dalgleish[6], can also be effected when the template and its partially formed products are spirals, by a similar process of rotation.

If it is considered that the original spiral in any of the foregoing examples is not free to rotate, the manipulations are still possible if the new or growing spirals are allowed to turn epicyclically about the original.

Adjacent spirals, with their axes close together so that one fits into the other, may also be manipulated by rotation. With systems of parallel spirals it is conceivable that an interlacing network or mesh may be formed by simple rotation.

Processes of the type here described are reversed when the direction of rotation is changed. With rotation some tendency to forward movement through the surrounding medium is to be expected. Apart from this, rotation permits a wide range of

manipulation with a minimum of displacement in the structures concerned.

Financial assistance from the National Research Council of Canada is acknowledged.

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[1] Darlington, C. D., "Recent Advances in Cytology" (Churchill, London, 1937).
[2] Watson, J. D., and Crick, F. H. C., *Nature*, **171**, 737 (1953).
[3] Delbrück, M., *Proc. U.S. Nat. Acad. Sci.*, **40**, 783 (1954).
[4] Gamow, G. (in the press).
[5] Pauling, L., and Corey, R. B., *Proc. U.S. Nat. Acad. Sci.*, **37**, 235 (1951).
[6] Dalgleish, C. E., *Nature*, **171**, 1027 (1953).

Dislocation Models in 1902?

One of the attractive aspects of the theory of dislocations is the extent to which simple mechanical models may be used for demonstrating the basic concepts. Of such models the bubble raft assembly of Bragg is perhaps known to the widest lay audience, and, while it is probably stating the obvious to say that such a model is of real value only against the background of the *concepts* of dislocation theory, it is, nevertheless, very interesting to find published illustrations of such a model which date from 1902.

Figs. 1 and 2 are to be found on pp. 12 and 13 of the printed version of the Rede Lecture, delivered on June 10, 1902, by Osborne Reynolds and printed by the Cambridge University Press. Osborne Reynolds was professor of engineering in the Owens College, Manchester (later incorporated in the Victoria University of Manchester), during 1868–1905; during those years he completed the researches—on the mechanical equivalent of heat, on high-lift pumps, on lubrication and, of course, on streamline and turbulent flow in fluids—with which his name will always be associated. Reynolds's lecture for 1902 was entitled "On an Inversion of Ideas as to the Structure of the Universe" and, dealing as it does with the "granular structure of space", seems at first sight to be out of the main stream of contemporary scientific thought.

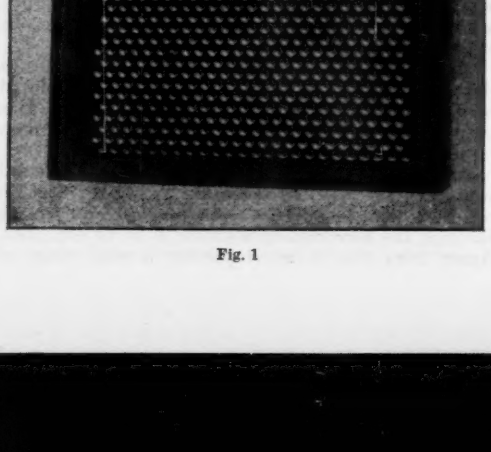

Fig. 1

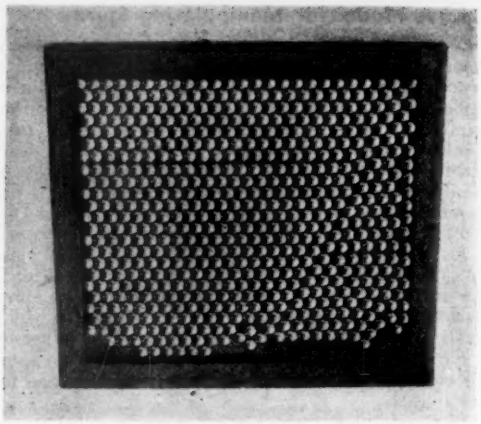

Fig. 2

A close study of the text of the lecture, however, reveals that the dislocation models, far from being merely fortuitous, spring from a clear intellectual concept. Reynolds is at considerable pains to distinguish between the close-packed regular piling of Fig. 1, for which the application of a "strain" (*sic*) would not allow any change of neighbours in the array, and the abnormal piling of Fig. 2 in which, because of the "abnormal gearing of the grains", an imposed "strain" may produce "relative motion of the grains and render(s) the medium elastic" (pp. 12–13). (We should to-day prefer to write "stress" and "plastic" rather than "strain" and "elastic"; but the meaning is clear.)

It is evident that the correlation between Reynolds's models of regular and dislocated close-packed arrays and the bubble models of modern dislocation theory is no merely superficial similarity and, indeed, both models stem from the same fundamental idea, namely, the great strength which would be expected of a perfectly packed array of spherical particles. That Reynolds's particles are not atoms in no way minimizes the validity of his basic concept.

The later pages of the lecture contain assertions on the nature of electricity and gravitation and on the propagation of light which read curiously to-day; but there are phrases which bring one up with a start: "Such motion has all the character of a wave in the medium; and that is what the singular surfaces, which we call matter, are—waves. We are all waves".

Finally, Reynolds returns to a demonstration of those extraordinary properties of sand which he had first described as "dilatation" in 1875. These phenomena, which were correctly ascribed to the different modes of packing of granular particles, have quite recently sprung into prominence again with the development of the new science of soil mechanics. But to Reynolds they had a far wider significance and they led him to those speculations on the nature of the physical world which he described in the Rede Lecture. This, to him, was his greatest work, and when he sat to Collyer he chose to be portrayed holding a bowl of marbles; perhaps he was right.

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J. A. L. Matheson

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June 18.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER IN PHYSICAL CHEMISTRY—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (August 4).

SCIENTIFIC OFFICER (male) at the Brown Trout Research Laboratory, Pitlochry, for duties chiefly connected with salmon research—The Establishment Officer, Scottish Home Department, Room 364, St. Andrews House, Edinburgh 1 (August 4).

LECTURER IN ANATOMY—The Registrar, The University, Manchester 13 (August 7).

PHYSICIST (with a good honours degree or equivalent) at the National Coal Board's Coal Survey Laboratory in Cardiff, to initiate studies of the physical and mechanical properties of South Wales coal seams—The National Coal Board, Staff Department, Hobart House, London, S.W.1, quoting SS/335 (August 7).

ASSISTANT LECTURER (preferably with interests in applied mathematics) IN THE DEPARTMENT OF MATHEMATICS—The Secretary, University College, Gower Street, London, W.C.1 (August 10).

LECTURER IN EDUCATION at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 15).

HEAD (with high academic qualifications, preferably an honours degree in mining, practical mining experience, and teaching experience, preferably in a Technical College or a University) OF THE MINING AND GEOLOGY DEPARTMENT—The Principal, Wigan and District Mining and Technical College, Wigan (August 17).

RESEARCH ASSISTANTS (2) (one with a good science degree in physics or physical chemistry) for investigations in selective flotation; (and the other with a degree in science or engineering) for research on the hydraulic transport of coal—The Registrar, The University, Leeds 2 (August 17).

PHYSICISTS AND MECHANICAL ENGINEERS (with a good honours degree or equivalent), to lead and engage in research work of national importance to increase coal production, concerned with fundamentals of methods of extracting coal from seams, strata support, conveying coal to the pit bottom and environmental conditions—The National Coal Board, Mining Research Establishment, Worton Hall, Isleworth, Middlesex, quoting SS/348 (August 21).

PROFESSOR OF PSYCHOLOGY—The Registrar, The University, Reading (August 24).

SENIOR LECTURER (with experience in research and teaching in one of the following fields: mycology, algology or anatomy) IN BOTANY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 28).

LECTURER, Grade II (with an honours degree in engineering, together with practical engineering experience and an interest in research), IN MECHANICAL ENGINEERING—The Registrar, The University, Birmingham 15 (August 31).

LECTURERS (3) IN THE DEPARTMENT OF PHARMACY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

SENIOR LECTURER IN PHARMACY at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 31).

SENIOR LECTURER or LECTURER (with special qualifications in mining geology and geological surveying) IN GEOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

CHAIR OF GEOGRAPHY at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 3).

ASSISTANT LIBRARIAN (graduate) at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 6).

LECTURER or ASSISTANT LECTURER (with qualifications in the realm of mathematical analysis) in PURE MATHEMATICS—The Registrar, The University, Hull (September 15).

READER IN MATHEMATICAL ANALYSIS at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 15).

CHAIR OF AGRICULTURE at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 30).

READER IN PURE OR APPLIED MATHEMATICS at the University of Oxford—The Secretary of Faculties, University Registry, Oxford (October 31).

ASSISTANT (Grade A) to teach pure and applied mathematics; and an ASSISTANT (Grade A) to teach physics—The Principal, Technical College, Queen Street South, Huddersfield.

ASSISTANT (Grade B) IN THE DEPARTMENT OF MATHEMATICS, The Technical College, Bradford—The Director of Education, Town Hall, Bradford.

ASSISTANT LECTURER, Grade B (with an honours degree in mathematics and capable of teaching practical mathematics to the standard of the higher national diploma in engineering) IN THE DEPARTMENT OF MATHEMATICS, College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff.

ASSISTANT PHYSICIST (Basic grade) at the Regional Radium Institute, Bradford—The Secretary, Royal Infirmary, Bradford.

ASSISTANT TO THE CHIEF TECHNICIAN—Prof. T. L. Bywater, Department of Agriculture, The University, Leeds 2.

ASSISTANT (with a first- or second-class honours degree in biochemistry or pure chemistry) IN THE DEPARTMENT OF BIOCHEMISTRY—The Secretary, The University, Edinburgh.

BIO-PHYSICO-CHEMICAL TECHNICIAN (preferably with preparative and analytical experience), for research on nucleic acid—The Medical Research Council, Biophysics Research Unit, King's College, Strand, London, W.C.2.

ELECTRICAL or MECHANICAL ENGINEER (with a first- or second-class honours degree or equivalent qualification in electrical or mechanical engineering) at a Ministry of Supply Research and Development Establishment near Sevenoaks, Kent, to assist in the basic development of mechanical and electromechanical devices for projectiles and rockets—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.286/6A.

GRADUATE CHEMISTS for fundamental and applied research in organic and physical chemistry—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

INTERNATIONAL TIN RESEARCH COUNCIL RESEARCH SCHOLAR (honours graduate in chemistry or with equivalent qualifications) for work on mechanisms of reactions of organo-tin compounds—The Registrar, University College, Leicester.

JOSEPH LUCAS RESEARCH FELLOW (with an honours degree in metallurgy, chemistry or physics) to investigate the structure and metallurgical properties of electro-deposits—The Registrar, The University, Birmingham 15.

LECTURER (Grade II) IN PHYSICAL METALLURGY—The Registrar, The University, Birmingham 15.

LECTURER IN AGRICULTURAL CHEMISTRY—The Principal, Seale-Hayne Agricultural College, Newton Abbot, Devon.

LECTURER (with a good engineering degree and some experience in industry and research) IN MECHANICAL ENGINEERING—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1.

LECTURERS (2) (with experience in some field of applied physics, for example, electronics, solid state physics, vacuum technology, applied) IN THE PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

PHYSICIST or ELECTRICAL ENGINEER (with an honours degree, some research experience, and a working knowledge of electronics) IN THE PHYSICS DEPARTMENT, for work on a problem in ultrasonic propagation—The Registrar, University College, Leicester.

RESEARCH FELLOW or RESEARCH SCHOLAR (qualified in mineralogy and petrology) IN THE DEPARTMENT OF GEOLOGY, to work on specific Antarctic problems and on material provided by the Falkland Islands Dependencies Survey—The Registrar, The University, Birmingham 15.

SENIOR MATHEMATICS MASTER—The Headmaster, St. Peter's School, York.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report of the Proceedings of the 1955 Conference of the Universities of Great Britain and Northern Ireland. Pp. 112. (London: Association of Universities of the British Commonwealth, 1956.) 3*s.* 6*d.* [75

Air Ministry: Meteorological Office. Professional Notes. No. 119. High Cloud Over Southern England. By R. J. Murgatroyd and P. Goldsmith. Pp. 20. (M.O. 524a). (London: H.M. Stationery Office, 1956.) 9*d.* net. [25

University of Cambridge: Department of Engineering. Report of the Head of the Department for the year 1954–55. Pp. 15. (Cambridge: The University, Department of Engineering, 1956.) [75

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1954–55. Kenya. By M. S. Hastie. Pp. 13. 9*d.* Northern Nigeria. Pp. 23. 9*d.* (London: Empire Cotton Growing Corporation, 1956.) [75

Scottish Home Department. Report for the year 1955 on the Royal Scottish Museum. By Dr. Douglas A. Allan. Pp. 16. (Edinburgh: Royal Scottish Museum, 1956.) [75

Discovery Reports. Vol. 28. Pp. 191–236: The Distribution of the Standing Crop of Zooplankton in the Southern Ocean. By P. Foxton. 17*s.* 6*d.* net. Title-page and Index to Volume 27. Pp. vii. 2*s.* 6*d.* (Cambridge: At the University Press, 1956.) [75

United Steel Companies Limited. Review of Progress 1955: Report for Employees. Pp. 28. (Sheffield: United Steel Companies Limited, 1956.) [75

Annual Report of the Royal Zoological Society of Scotland for the Financial Year ending 31st December 1955. Pp. 52. (Edinburgh: Royal Zoological Society of Scotland, 1956.) [105

Inorganic Qualitative Analysis: a Concise Scheme Using the Semi-Micro Technique. By H. Holness. Pp. 12. (London: Sir Isaac Pitman and Sons, Ltd., 1956.) 4*s.* [105

University of Reading: Museum of English Rural Life. Report, 1955. Pp. 16. (Reading: The University, 1956.) 6*d.* [105

National Coal Board: Scientific Department. Science Bulletin, Spring 1956. Pp. 22. (London: National Coal Board, 1956.) [105

Friends of the Lake District. Report and News Letter, April, 1956. Pp. 24. (Ulverston: Friends of the Lake District, 1956.) [105

Colonial Development Corporation. Annual Report and Statement of Accounts for year to 31.12.55. Pp. v+55. (London: H.M. Stationery Office, 1956.) 2*s.* 6*d.* net. [105

Overseas Food Corporation. Annual Report and Statement of Accounts for the year ended 31st March, 1955. Pp. viii+183+8 plates. (London: H.M. Stationery Office, 1956.) 6*s.* 6*d.* net. [105

European Brewery Convention. Trials 1954—Report of the Barley Committee. Pp. 84. (London: Institute of Brewing, 1956.) [105

Combining for Research: the Work of the Industrial Research Associations in the Government Scheme. By Prof. Norman F. Ramsey. Pp. 32+16 plates. (London: Department of Scientific and Industrial Research, 1956.) [145

Hannah Dairy Research Institute. Report for the Three Years ending 31st March, 1956. (Twenty-fifth to Twenty-seventh Annual

Reports (combined).) Pp. 44+3 plates. (Kirkhill, Ayr: Hannah Dairy Research Institute, 1956.) [145

John Innes Horticultural Institution. Forty-sixth Annual Report, 1955. Pp. 36. (Bayfordbury, Hertford: John Innes Horticultural Institution, 1956.) 3s. [145

Royal Commission on Awards to Inventors—Fourth and Final Report. Pp. 20. (Cmd. 9744.) (London: H.M. Stationery Office, 1956.) 9d. net. [145

Rowett Research Institute. Collected Papers: Summary and Subject Reviews. Vol. 12. Pp. ii+55. (Bucksburn: Rowett Research Institute, 1956.) [145

Institution of Electrical Engineers. Annual Report for 1955–56. Pp. 24. (London: Institution of Electrical Engineers, 1956.) [145

Institution of Chemical Engineers. Annual Report of the Council for the year ended 31 December, 1955. Pp. 16. (London: Institution of Chemical Engineers, 1956.) [145

Department of Scientific and Industrial Research. Automation: a Report on the Technical Trends and Their Impact on Management and Labour. Pp. viii+106. (London: H.M. Stationery Office, 1956.) 6s. net. [155

Lancashire Dynamo Holdings, Limited. Directors' Report and Accounts, 1955. Pp. 15. (London: Lancashire Dynamo Holdings, Limited, 1956.) [155

Geochemistry of Iodine: Iodine in Rocks, Minerals and Soils—Annotated Bibliography, 1825–1954, with Review and Tables. Pp. viii+150. (London: Chilean Iodine Educational Bureau, 1956.) [175

Transactions of the Royal Society of Edinburgh. Vol. 63, Part 1 (No. 3): A Petrological Study of the Arthur's Seat Volcano. By Dr. R. H. Clark. Pp. 37–70. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 9s. 3d. [175

British Medical Bulletin. Vol. 12, No. 2: Symposium on "Neuro-Otology." Pp. 91–160+4 plates. (London: British Council, 1956.) 15s. [175

Management Succession: The Recruitment, Selection, Training and Promotion of Managers. Pp. vii+139. (London: Acton Society Trust, 1956.) 10s. 6d. [175

Department of Scientific and Industrial Research: National Physical Laboratory. Mass Spectrometer Researches. By Dr. G. P. Barnard. Pp. iii+62+4 plates. (London: H.M. Stationery Office, 1956.) 3s. 6d. net. [175

Other Countries

Canada: Department of Northern Affairs and National Resources, National Museum of Canada. Bulletin No. 135: The Vascular Plants of the Western Canadian Arctic Archipelago. By A. E. Porsild. Pp. iv+226 (24 plates). 2.50 dollars. Bulletin No. 136: Annual Report of the National Museum of Canada for the fiscal year 1953–54. Pp. iv+122 (16 plates). 1.50 dollars. Bulletin No. 137: Ecological Control of the Occurrence of Barnacles in the Miramichi Estuary. By E. L. Bousfield. Pp. iii+69. 1.25 dollars. (Ottawa: Queen's Printer, 1955.) [25

American Philosophical Society. Year Book 1955. Pp. 668. (Philadelphia: American Philosophical Society, 1956.) [25

United States Department of Agriculture. The Brown-Tail Moth: How We Fight It. Pp. 6. (PA 282.) The Gypsy Moth: How We Fight It. Pp. 8. (PA 285.) Leaflet No. 401: The White-Fringed Beetle: How to Control It with Insecticides, How to Prevent Its Spread. Pp. 8. 5 cents. (Washington, D.C.: Government Printing Office, 1956.) [25

Stanford Research Institute. Report of Operations, 1955. Pp. 47. (Menlo Park, Calif.: Stanford Research Institute, 1956.) [25

United States Department of the Interior: Geological Survey. Bulletin 1009-M: Botanical Prospecting for Uranium on La Ventana Mesa, Sandoval County, New Mexico. By Helen L. Cannon and W. H. Starrett. Pp. iii+391–406. 15 cents. Water Supply Paper 1320-A: Floods of June 1953 in Northwestern Iowa. Prepared under the direction of J. V. B. Wells. Pp. vii+68+2 plates. n.p. (Washington, D.C.: Government Printing Office, 1955 and 1956.) [25

Chicago Natural History Museum. Fieldiana: Zoology. Vol. 33, No. 5: Philippine Zoological Expedition, 1946–1947. On the Status and Relations of *Crocodylus mindorensis*. By Karl P. Schmidt. Pp. i+535–540. (Chicago: Chicago Natural History Museum, 1956.) 15 cents. [25

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Museum of Comparative Zoology at Harvard College. Breviora. No. 51 (January 27, 1956): A Small Mustelid from the Thomas Farm Miocene. By Stanley J. Olsen. Pp. 5. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1956.) [25

Annals of the New York Academy of Sciences. Vol. 63, Article 5: Ascites Tumors as Tools in Quantitative Oncology. By T. S. Hauschka and 40 other Authors. Pp. 637–1031. 4.50 dollars. Vol. 63, Article 6: Cancer Cytology and Cytochemistry. By J. Kopac and 51 other Authors. Pp. 1033–1462. 4.50 dollars. (New York: New York Academy of Sciences, 1956.) [25

Proceedings of the United States National Museum. Vol. 105, No. 3350: Lanternflies of the Family Issidae of the Lesser Antilles (Homoptera: Fulgoroidea). By R. G. Fennah. Pp. 23–48. Vol. 105, No. 3359: Type Species of the Genera and Subgenera of Parasitic Wasps Comprising the Superfamily Proctotrupoidea (Order Hymenoptera). By C. F. W. Muesebeck and Luelia M. Walkley. Pp. 319–419. Vol. 106, No. 3362: Revision of the Milliped Genus Dixioria (Polydesmida: Xystodesmidae). By Richard L. Hoffman. Pp. 20. (Washington, D.C.: Smithsonian Institution, U.S. National Museum, 1956.) [25

United States Department of Commerce. Weather Bureau. Technical Paper No. 15: Maximum Station Precipitation for 1, 2, 3, 6, 12, and 24 Hours. Part 15: Alabama. Pp. ii+54. 35 cents. Technical Paper No. 25: Rainfall Intensity–Duration–Frequency Curves for Selected Stations in the United States, Alaska, Hawaiian Islands, and Puerto Rico. Pp. vi+53. 40 cents. (Washington, D.C.: Government Printing Office, 1955.) [25

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Industrial Equipment and Its Ageing from the Designer's Viewpoint: a Study on Engineering Economics. By Tauno Lipas. Pp. 132. (Jyväskylä: Tauno Lipas, 1956.) [25

United States Department of the Interior: Geological Survey. Water-Supply Paper 1263: Geology and Ground-Water Resources of the Missouri River Valley in Northeastern Montana. By Frank A. Swenson. (With a section on the Quality of the Ground Water by Walton H. Durum.) Pp. iv+128+1 plate. (Washington, D.C.: Government Printing Office, 1955.) 1.25 dollars. [75

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Bulletin of the Earthquake Research Institute, Tokyo University. Supplementary Volume 4. Part 6: Gravity Survey along the lines of Precise Levels throughout Japan by Means of a Worden Gravimeter. Part 7: Tôhoku District. By Chuji Tsuboi, Akira Jitsukawa and Hirokazu Tajima. Pp. 311–406. (Tokyo: Earthquake Research Institute, Tokyo University, 1956.) 470 yen. [75

United States Department of Commerce: National Bureau of Standards. Building Materials and Structures Report 146: Plasticity and Water Retentivity of Hydrated Limes for Structural Purposes. By Ernest M. Levin, Walter F. Clarke and Lansing S. Wells. Pp. ii+10. (Washington, D.C.: Government Printing Office, 1956.) 15 cents. [75

International Scientific Radio Union. Proceedings of the 11th General Assembly held in The Hague from August 23rd to September 2nd, 1954. Vol. 10, Part 2: (Commission 2)—On Radio and Troposphere. Pp. 90. (Brussels: International Scientific Radio Union, 1956.) 100 Belgian francs; 14s. 6d.; 2 dollars. [75

Chicago Natural History Museum. Fieldiana: Zoology. Vol. 34, No. 38: A New Genus of Minute Fungus-Pore Beetles from Oregon (Coleoptera: Ptiliidae). By Henry S. Dybas. Pp. 441–448. 20 cents. Vol. 34, No. 39: A New Snake of the Genus Tantilla from West Texas. By Sherman A. Minton, Jr. Pp. 449–452. 15 cents. (Chicago: Chicago Natural History Museum, 1956.) [75

Ministério do Trabalho, Industria e Comércio. Instituto Nacional de Tecnologia. Lógica Algébrica e Automatismo. Da Theodore Oniga. Pp. 51. Bibliografia Brasileira de Quimica Tecnológica: Periodicos e Publicacoes. Vol. 1, No. 1 (1954). Pp. 153. (Rio de Janeiro: Instituto Nacional de Tecnologia, 1954.) [75

Atti della Società Peloritana di Scienze Fisiche Matematiche e Naturali. Vol. 1, Anno 1955, Fasc. 1. Publicazione trimestrale Abbonamento: L. 2000 per l'Italia; L. 4000 per l'Estero. Un fascicolo separato: L. 500 per l'Italia; L. 1000 per l'Estero. (Messina: Società Peloritana di Scienze Fisiche, Matematiche e Naturali, Università di Messina, 1955.) [75

Notas de Fisica. Vol. 2, No. 8 Effect of the Finite Size of the Nucleus on μ-Pair. Production by Gamma Rays. By George H. Rawitscher. Pp. 11. (Rio de Janeiro: Central Brasileiro de Pesquisas Fisicas, 1955.) [75

Report on the Scientific Results of the *Michael Sars* North Atlantic Deep-Sea Expedition, 1910. Isospondyli. 1: Gymnophotodermi and Lepidophotodermi from the *Michael Sars* North Atlantic Deep-Sea Expedition 1910. By Einar Koefoed. (Vol. 4, Part 2, No. 4.) Pp. 21+3 plates. (Bergen: The University, 1956.) [75

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